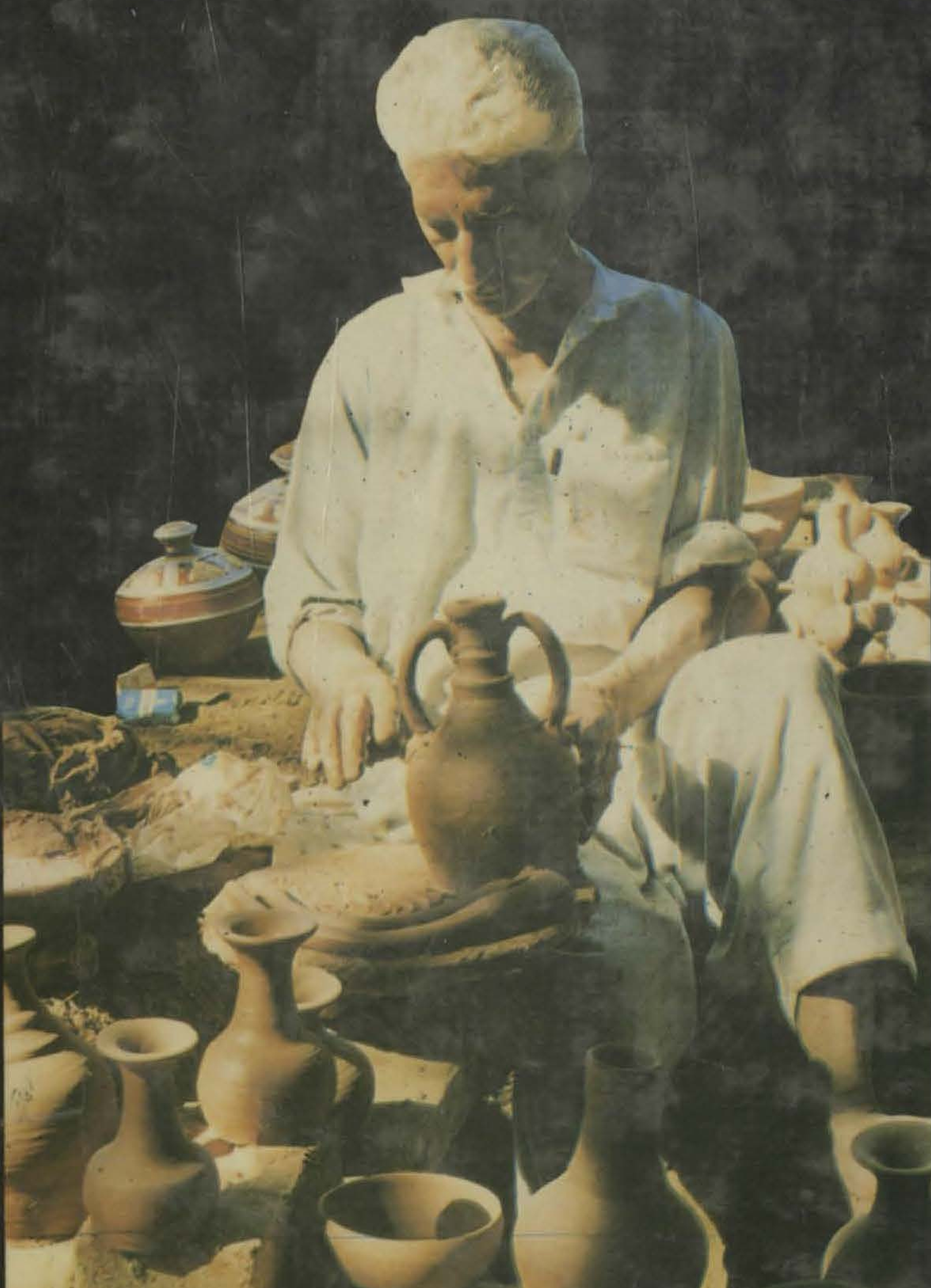
Owen S. Rye
and
Clifford Evans

FIELD AND
LABORATORY
STUDIES

SMITHSONIAN
CONTRIBUTIONS
TO
ANTHROPOLOGY

NUMBER 21

TRADITIONAL POTTERY TECHNIQUES OF PAKISTAN



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Traditional Pottery Techniques of Pakistan

FIELD AND LABORATORY STUDIES

Owen S. Rye and Clifford Evans

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To

HANS E. WULFF

a pioneer in the study of traditional crafts
whose guidance and scholarly leadership
developed the Smithsonian Institution's program
of the ethnotechnology of South Asia

FOREWORD TO THE LOK VIRSA EDITION

There is an acute shortage of text books and informational material on the material culture of Pakistan. Although the present work was published in 1974 in the United States, it is still the only comprehensive reference work on the subject of traditional pottery in Pakistan.

Lok Virsa has the mandate of collecting, documenting and disseminating all aspects of Pakistan's traditional heritage. The Lok Virsa Museum has the largest single collection of traditional Pakistani pottery. The existing collection has been scientifically documented, and an annotated catalogue of the pottery collection will be published shortly. Research on the subject, both original and commissioned is continuing in collaboration with cultural and art institutions in Pakistan. This reprint will fill the gap until such a time that a detailed and update survey of pottery techniques can be published.

Lok Virsa acknowledges with gratitude for the kind permission by the Smithsonian Institution, Washington DC, USA to reprint a limited edition of this work.

It is hoped that students and scholars of material culture, fine arts, ceramics and allied disciplines will draw knowledge and inspiration from this reprint.

AHMAD FARAZ,
Executive Director.

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ABSTRACT

Rye, Owen S., and Clifford Evans. Traditional Pottery Techniques of Pakistan: Field and Laboratory Studies. *Smithsonian Contributions to Anthropology*, number 21, 283 pages, 15 tables, 38 figures, 82 plates, 1976.—The first part of this work deals with detailed observations obtained during four field expeditions (1967–1971) in Pakistan, for pottery making of unglazed ware in 13 areas and glazed ware in 5 major centers.

For each center a brief outline of the area is given, followed by an outline of the potter's craft under the following guidelines: tools and equipment, materials gathering and preparation, forming and finishing techniques, decoration (including slips and pigments), glazing, kilns and firing, and types of ware. Most of the common pottery-making techniques in Pakistan are included although fieldwork was primarily in the Northwest Frontier Province and Panjab. Pottery-related crafts such as brickmaking and *tanur* (bread oven) making are briefly discussed.

In the second part of this work detailed relationships between pottery-making techniques, outlined in the first section, are developed under the headings of tools and equipment, materials, forming and finishing techniques, slips, pigments and colorants, glazes, and kilns and firing. Technical studies include mineralogy studies of clays and tempering materials, particle size distribution studies of nonplastic tempering materials, and electron microprobe analyses of fired glazes.

The monograph provides essential data for use in comparative studies of archeological ceramics from Pakistan, as well as a detailed record of the rapidly disappearing pottery crafts of that country, including five appendixes and a glossary.

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Preface

This monograph reports the results from field work in Pakistan and the laboratory study of materials collected. The Pakistan project was initiated by Hans E. Wulff, as an extension of his early research in Persia (Iran). Wulff lived and worked in Persia for five years between 1936 and 1941. During this period he became increasingly devoted to a study of Iranian craftsmen, traveling extensively in Iran, watching craftsmen of all types at work, interviewing, photographing, and gaining a deep understanding of the people and their technology. Wulff's (1966) Persian work was brought together in his monograph *Traditional Crafts of Persia.*

Wulff went to Persia for the last time in 1966, on a field trip sponsored by the Smithsonian Institution and the University of New South Wales, Sydney, Australia, where he was teaching the history of Islamic science and technology in the School of Mechanical Engineering. He had felt for some time that Pakistan would also be rich in craft traditions, so after his studies in Persia he visited Pakistan for a very brief, preliminary survey from September to early December 1966. From this survey he planned a more intensive program of craft research in Pakistan. With encouragement form Smithsonian Institution scientists (originally from Richard Woodbury and later from Clifford Evans and Gus Van Beek, who became the coordinators of the Ancient Technology Program of the Department of Anthropology of the National Museum of Natural History) and financial support from both the Smithsonian Institution and the University of New South Wales, he returned to Pakistan in November 1967. This was the first expedition of the program that later was to become known formally as "Ethnotechnology of South Asia Research Program," reflecting Wulff's thinking of the transmittal of craft techniques on a regional basis, as well as their little-changed continuation in a specific area over periods of time.

Wulff worked in Sind, Pakistan, on the formal Smithsonian and University of New South Wales expedition through November and December 1967.. He was accompanied by his assistant, Donald M. Godden of the University of New South Wales, and the expedition photographer, Charles Walton of St. Ives, New South Wales, a longtime personal friend. On 26 December Wulff died of a cerebral hemorrhage at Sukkur. The expedition's field work was continued under the leadership of Godden with the Smithsonian's approval. All notes and photographs from Wulff's work were made available to later workers in the program. Unfortunately, Wulff's field notes were still in very rough, incomplete form, prepared in his own very concise style, difficult to follow, and in a unique "shorthand" of German-English and unknown abbreviations. The notes were made available from Wulff's personal files by his late widow and daughters in Sydney, Australia. His photographic files of the Pakistan fieldwork are now in the Department of Anthropology of the Smithsonian Institution and were cataloged along with his observations, even if brief. Godden in Australia has rewritten some of Wulff's notes so that they are now usable, but they are unpublished. Some of Wulff's field work has been irretrievably lost due to his untimely death in the field before he had transcribed his unique notes into expanded field reports.

After the four-month 1967–68 field season had been completed, the research project was reorganized by the financial supporters of the field work, the Smithsonian Institution. It was agreed mutually between the officials of the University of New South Wales, Kensington, Australia, and the Smithsonian Institution, in Washington, D. C., that the field studies of the "Ethnotechnology of South Asia Research Program" would continue, with one project in Pakistan and one in Ceylon, both to be funded by the Smithsonian

Institution's Ancient Technology budget, but each as totally independent projects of the larger program. Under this new arrangement, two further seasons of four month's field work were completed in Pakistan with Donald Godden of the Department of Industrial Arts of the University of New South Wales, Australia, as principal investigator, during 1968–69 and 1969–70, whereas Professor L. M. Haynes would work several seasons in Ceylon.

Wulff's unanticipated death had caused a re-evaluation of the specific aims and scope of the Pakistan field work. It emerged as a detailed survey study, the aim being to build up as wide a view as possible of the nature of traditional craft practices in Pakistan, before they disappeared or suffered total acculturation and to isolate areas for later, more intensive studies. One important guiding factor emerged: Pakistan, as a developing nation, was undergoing many changes. Developments of new production methods were cutting into the realm of the traditional craftsmen in many areas, and ancient techniques were being lost. It was a matter of urgency in some cases to locate and reach craftsmen who would soon abandon their traditional methods and skills for partial or complete replacement by new technology. Within the context of these overall guidelines, the first three field seasons saw the completion of the initial surveys of all four provinces of Pakistan. Photographs and unpublished reports from this work were deposited in the Department of Anthropology, National Museum of Natural History of the Smithsonian Institution, along with an extensive collection of specimens.

With the initial survey completed, a further field season was planned for 1971, with continued financial support from the Smithsonian Institution. It was decided that this season would last about eight months. While the general survey throughout Pakistan would continue in some previously unstudied areas, now selected crafts would be studied in depth. The senior author, as an expert in ceramics and a recent doctoral graduate of the Department of Industrial Arts at the University of New South Wales, was invited to accompany the 1971 expedition and study the pottery crafts of Pakistan.

The project team under the leadership of Donald M. Godden, accompanied by Elaine Godden, photographer Charles Walton, and Owen Rye arrived in Karachi in March 1971 and finalized administrative details to go to the interior immediately since the Pakistan government had approved our itinerary. Most of the travel was to be by road, using a four-wheel drive vehicle, which had been acquired for the project in 1967. The expedition traveled first by road to Peshawar, in the Northwest Frontier Province, where the initial intensive field work was centered.

A brief survey, coupled with knowledge gained on previous expeditions, showed that there were many pottery workshops in the districts surrounding Peshawar that produced both unglazed ware and a characteristic style of glazed ware. The first detailed work with potters was not accomplished until we reached Dir, some two days drive north of Peshawar. After working around Dir we returned to Peshawar, and pottery workshops in Pabbi and Zakhel Bala were studied. These initial studies brought an awareness of the hospitality and cooperation of the potters, qualities which were to be repeated in almost every workshop that Rye visited throughout Pakistan.

After some time in Peshawar the team planned to move to Chitral, but these plans were thwarted by natural obstacles. The road leading to Chitral from Peshawar was still closed by snow in the Lawarai Pass, and the air route between these two centers was also closed for extended periods. Thus the expedition was diverted to districts south of Peshawar on the western side of the Indus River, known as Kohat, Bannu, and Dera Ismail Khan.

By May 1971 the concensus of opinion among local authorities was that it would be possible to travel by road to Chitral, but only by hiring jeeps at Dir to cross the Lawarai Pass. The concensus proved correct, and the reason for opinions to the contrary also became obvious on this journey, as the road had only been opened by building temporary passages through large snow drifts with twigs laid across the snow.

In the Chitral valley the team worked around Chitral and then traveled north along

in the United States embassy and consulates in Pakistan, the field work in Pakistan, and in the later studies in the laboratory, the analytic work and the preparation of the monograph of publication in Washington, D. C., at the Smithsonian Institution.

All the field studies were funded from the Smithsonian Institution's Ancient Technology budget, primarily from Pl 480 reserves in the form of Pakistani rupees, with some hard dollar support from the Department of Anthropology's federal budget. Coordinators of the field projects and the administration of the funds within the Smithsonian Institution itself from the inception of the first project with Wulff were Clifford Evans, assisted by Gus Van Beek. Many persons made it possible to carry out the fieldwork, but the Office of International Programs was particularly cooperative and later the Smithsonian Research Foundation assisted the field workers with minimal delays and maximum effectiveness in overcoming a variety of administrative problems ranging from official permissions to accounting procedures.

From the beginning of the project, encouragement and practical assistance were received from Mr. Aslam Malik, then Pakistan High Commissioner in Australia, who had been instrumental in convincing his government to grant the original permission for Wulff to work in Pakistan when the Smithsonian Institution had failed through normal diplomatic channels in Washington, D. C.

Within Pakistan, the Ministry of Foreign Affairs was responsible for coordination between the investigators and all local officials. The details of travel and the arrangement of meetings with local officials were the responsibility of liaison officers commandeered from the Pakistan government's Small Industries Corporation. At the district and local levels excellent cooperation and magnificent hospitality were extended by district commissioners and other officials too numerous to mention by name. An exception can be made for our liaison officers, Aziz Ullah Khan Khalil, who worked with the team for six months in 1971, and Mahsood Ahmed Siddiqui, who deserve special commendation.

Administrative assistance was also received from United States consulates throughout Pakistan, as well as from the embassy in Islamabad. Mr. Chandler P. Roland and others from the Consulate in Karachi were particularly helpful. Also in Karachi, Mr. and Mrs. George Verhulst of the United States consulate virtually turned over control of their home to us for a month and were extremely helpful in every way possible.

Scientific and scholarly discussions were held with members of universities and museums throughout Pakistan. Various staff of the Peshawar University were helpful; special thanks are due to Mr. Mohd Taqi of the Lahore Museum, who allowed many pieces to be removed from display cases for detailed examination, measurement, and photography.

Abdul Samad Khan from Drosh in Chitral worked with us for over six months; his command of nine languages (including "a little English") was a very valuable asset to the expedition. He was always more than willing to do anything asked of him and he soon ceased to be only a "guide and interpreter" (his official assignment), and became a valued friend of all members of the field expedition.

Many others in Pakistan also contributed in their own way. A flood of names come to mind: Mr. A. K. Brohi, John Goss, Jan de Voss, Mike Birkenhead, Khuswakt ul-Mulk and members of his family in Chitral including the inimitable Burhan ud-Din, the subject of anecdotes in many travel books, Shafar the jeep-driver, and his "conductor," Gul Rahman and Rahim Gul from Peshawar, Majid Khan from Bomboret. The list grew every day in Pakistan and to those few mentioned by name and the many not, we are grateful for their assistance and comradeship.

All black-and-white film development was done by previous agreement with the Smithsonian Institution Photo Services by Car Studios in Karachi and their work of development, contact printing, and some enlargements was of consistently high standard.

To Rye, of course, the central people in all of this travel were the potters themselves. Like craftsman of all kinds with whom we worked, they were, almost without exception, extremely hospitable and pleased to demonstrate their skills. Many of their names are

mentioned through this work. For any errors or omissions, Rye, as a fellow potter apologizes.

Khan Zada, the dignified old potter of Dir, tolerated intrusion into his privacy, and we thank him with respect. Afzal Sarwar of Nowshera generously donated a night without sleep and much puzzling over synonyms to prepare a translation of *The Potter's Book*. Dr. D. N. MacKenzie, of the School of Oriental and African Studies, London University, checked the translation and made some useful suggestions; he also identified the Qur'anic verses quoted in the book. Professor F. Matson, Pennsylvania State University, freely shared his knowledge and findings, including a translation of his copy of *The Potter's Book,* made by Abdul Raziq Palwal of Kandahar, and made many helpful comments.

Members of the 1971 field research teams were all directly or indirectly associated with the University of New South Wales in Australia, where Professor L. M. Haynes, head of the Department of Industrial Arts, was responsible for general coordination between the University and the Smithsonian Institution.

This publication was prepared in its first draft in Washington, D. C., during 1972–73, while the senior author held a postdoctoral fellowship at the Smithsonian Institution, and later in the latter part of 1973 and 1974 when the senior author was appointed a Research Associate in the Department of Anthropology of the National Museum of Natural History, Smithsonian Institution. The junior author did not participate in the field work. Nevertheless, as the co-principal investigator of the Program within the Smithsonian Institution administration of the foreign currency grant most actively involved in the extensive correspondence, the permanent filing of the field catalogs and reports, the negatives, colored slides and photo catalogs, and the specimen catalogs and arrival of the large collections of artifacts for the Smithsonian's collections, the junior author was conversant with the data long before the study and writing began. The junior and senior authors worked closely at all times from the earliest stage of the study to the final manuscript preparation. The latter phases were slowed down by communication via mail half way around the globe since Rye in late 1974 returned to Australia via a small field project in Israel. Hence a large portion of the final manuscript preparation, table presentation, reorganization and conformity to the myriad of details necessary for any publication series fell to the junior author in consultation with the staff of the Smithsonian Institution Press.

Many persons within the Smithsonian contributed in some way to the work and were helpful in a multitude of situations; it is not possible to single out every one, but a few do deserve special mention:

Special appreciation must be expressed to Theodore A. Wertime, Research Associate in the Department of Anthropology, Smithsonian Institution, for the introduction of his long-time friend Hans E. Wulff in 1966 to the Smithsonian administrators and curators and for his continued interest in various aspects of research in ancient technology.

Dr. Dan Nicolson of the Department of Botany gave advice on botanical literature and identified specimens. Useful discussion was had with various people at the Freer Gallery, including Dr. T. Chase, Dr. Atil, and Mrs. J. Knapp. George Phebus, Robert Elder, and John Ritch of the Anthropology Department Processing Lab handled the collections and cataloged and accessioned the materials into the permanent records. John Ritch was particularly helpful during the compiling and editing stages of the manuscript preparation in resolving errors and inconsistencies in the USNM catalog numbers, field numbers, text and plate references and actual specimens which had developed over the many years of field collecting and manuscript writing.

Dr. Richard Organ and the staff of the Smithsonian's Conservation Analytical Laboratory contributed all of the optical emission spectroscopic studies of material and were always willing to discuss and advise on problems of identification of materials; H. Westley was particularly helpful. Assistance with x-ray diffraction and other mineral identification studies were received from Dr. J. Pierce, R. Robinson, and Harrison Sheng,

all of the sedimentology unit of the Department of Paleobiology; the laboratory and instrument facilities in that division were made readily available to carry out special research work.

Dr. William Melson of the Department of Mineral Sciences of the National Museum of Natural History became interested in the problem of glaze analyses and actively promoted cooperation with that department. Microprobe samples were prepared by Grover Moreland and Richard Johnson. The samples were analyzed by Dr. J. Nelen, who contributed many days of work both to the analyses and to the examination and interpretation of the data, and co-authored Appendix 4. William Potts, a Smithsonian predoctoral fellow, discussed many aspects of the work and helped to give insight on the relationships with studies in archeology. C. Obermeyer also helped in solving equipment problems of various kinds, ranging from the kiln to the spectographic equipment. Dr. A. E. Bence of Stony Brook University, New York, provided the Pb-Sn correction factors.

Two major components in the preparation of this publication were the photographs and illustrations. Vic Krantz of the Smithsonian NMNH Photolab was particularly helpful with advice on any photographic problem; he also photographed the specimens from the collections in the Department of Anthropology. The department's scientific illustrators, George Robert Lewis and Marcia Bakry, showed remarkable patience in persevering with ever-changing graphic requirements; the quality of the final art speaks for itself.

While working at the National Museum of Natural History, two volunteers also contributed: Jane Adams converted Rye's field photographic files from their "miscellaneous" state into an orderly and usable system, and John Wilson prepared all of the analytic and experimental samples and assisted with firing experiments. Special thanks are due Bethune Gibson, supervisor of the Anthropology Conservation Laboratory, who allowed a temperature-controlled kiln to be set up, occupying useful space, and used in her laboratory.

Translations from Pakistani languages were checked by Dr. C. Shackle and Dr. D. N. MacKenzie of the School of Oriental and African Studies, London University; they also went through lists of transliterations and converted these to an acceptable form. Any errors or inconsistencies in transliteration of words in this study, however, are not theirs but Rye's.

Sandra Lantz helped with all aspects of the preparation of the manuscript for publication and although both authors fully recognize and appreciate her role, the senior author is particularly grateful for all her practical contributions. Many had a role in the various typings; thanks are especially due to Laura Kreiss, Deborah Hanson, Hazel W. Fermino, and Gloria Jenkins. Mrs. Eleanor Haley deserves special commendation in taking all the edited complex tables and converting them into neat, camera-ready copy according to the standards required by the Smithsonian Press.

At the Smithsonian Institution Press, Joan Horn, editor, carried out the arduous task of editing the manuscript, preparing it for the printer, and nursing it through all the stages of growth to final maturity in the published monograph. Vern Shaffer, series production manager, gave his expert advice on mounting the plates and figures and preparing them from a variety of field and laboratory shots, as well as assisting in the final preparation of the numerous text tables. Al Ruffin, series managing editor, gave unstintingly of his time and energy to see the large and complex manuscript through the various stages until its birth as a *Smithsonian Contributions to Anthropology*.

Don Godden, principal investigator for the various field projects in Pakistan after Wulff's death, has allowed use of his own field notes and photographs, as well as corresponding regularly on many questions related to the field work. His contributions and his cooperation are gratefully acknowledged, as well as his successful leadership of the field projects.

November 1974

TRADITIONAL POTTERY TECHNIQUES OF PAKISTAN

Owen S. Rye and Clifford Evans

Introduction

Previous Studies

The nation now known as Pakistan did not exist independently before 1947, when the former British Commonwealth member country India was divided into two separate nations. One, with predominantly Muslim population, became Pakistan; the other retained the name "India." Until 1971 Pakistan existed as two geographically separated units, but in 1971 the unit which had been East Pakistan broke away and formed a separate nation, Bangladesh. The pre-1971 West Pakistan geographic region then became known as Pakistan. Thus, the area relevant to the present work has had three names within this century.

Within this monograph the region which post-1971 has been called "Pakistan" will be gievn this name for consistency, independent of the time period. Reference to the map (Figure 1) will provide orientation of the region and all its provinces and geographical zones in relationship to neighboring countries. The field research was all made within the four major regions of Pakistan, known as Sind, Panjab, the Northwest Frontier Province, and Baluchistan.

There is very little literature containing ethnographic observations of pottery making in Pakistan, and no known published work has included a survey of this craft for the country as a whole. The relevant literature available at present can be divided into two groups: accounts from the nineteenth century, generally prepared by officers of the British administration; and recent studies in the countries neighboring Pakistan, which in relation to the present monograph are extremely useful from a comparative viewpoint.

A standard for studies of this kind has been set by the late Hans Wulff's *Traditional Crafts of Persia* (1966). In this impressive publication, Wulff has presented the whole spectrum of crafts in Persia from the 1930s to the 1960s, placing individual crafts in a background of their historical development. While individual sections of Wulff's work, such as ceramics, can be criticized because of some inconsistencies and faults of presentation (he was not an expert ceramist), the work is a major effort of scholarship and a milestone in the study of traditional crafts.

Wulff had planned to extend his intensive studies of traditional crafts to Pakistan. Except for a general survey, only a month of field work had been completed when he died in Pakistan. The present monograph incorporates Wulff's unpublished notes as much as possible. Unfortunately, due to the inability of his coworkers to decipher his highly abbreviated notes and mnemonic devices known only to him, the notes are limited in their utility.

The nineteenth century literature relating to ceramics in Pakistan also provides very little useful data. During the nineteenth century most of the area now forming India and Pakistan was under British rule. Many publications by the British administration and individuals date from this period. These works suffer almost uniformly from two faults: the writers give no indication of their methods of information gathering, whether by direct observation or from word-of-mouth sources, and later writers tend to quote from earlier English sources without acknowledgment. The "Gazetteers" of the British Administration were produced for specific geographic or political regions, and each contained administrative data concerning population, tribal and religious divisions, agricultural products and manufactures, and a brief history of the region. Many of these Gazetteers have only brief references to pottery making.

Detailed studies of pottery making were reported by Dobbs (1895) for areas of Northwestern India, and Halifax (1892) for the Panjab, half of which is now in India and half in Pakistan. Both of these works contain much useful ethnographic data. However, some of the technical assertions of Halifax are dubious. For example, his statements about Multan ware

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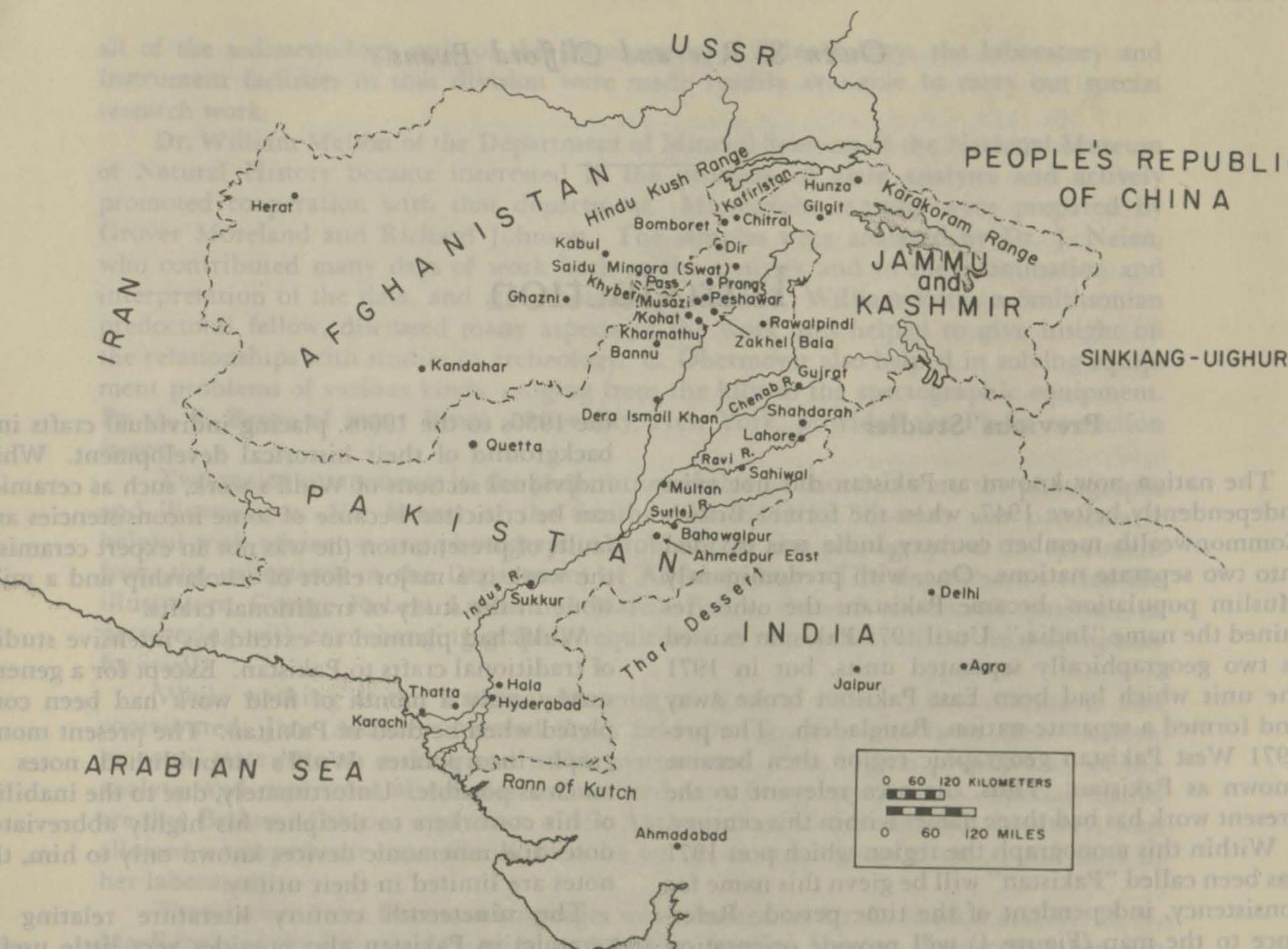


FIGURE 1.—Pakistan and nearby regions, showing centers of pottery making included in the present work.

probably reflect the potter's attempts to disguise trade secrets rather than give a true record of technical procedures.

An earlier work that was much-quoted by later English writers was that of Baden-Powell (1872:220–223). This includes descriptions of procedures in many crafts other than pottery. The section on pottery briefly refers to types of ware made in various locations. In discussing glazed pottery Baden-Powell quotes at length from a pamphlet published at the Central Jail, Lahore, without giving any indication of the source of the techniques reported. The techniques for glaze preparation reported by Baden-Powell cannot be related to practices prevailing in any specific location in India or Pakistan, independent of English influence, and the data must be regarded as of limited reliability until reconstruction of these techniques shows them feasible. Another much quoted work is that of Birdwood (1880). Much of his ethnographic and technical data for pottery is taken directly from Baden-Powell; his useful comments on vessels and tiles in the India Museum (now the Victoria and Albert Museum, London) are almost lost in the flowery rhetoric of his classical Greek and Roman allusions.

Two very valuable studies exist for comparison of pottery techniques in neighboring countries. The work of Saraswati and Behura (1966) of the Anthropological Survey of India is a thorough study of techniques of potters in India, and is particularly valuable because these writers have produced regional comparisons of variations in different aspects of the potter's craft. There are no detailed studies of the potters' materials, such as clays or pigments. Saraswati and Behura divide India into three major "pottery zones," the northwest, southeast, and central mixed, on the basis of comparison of techniques, primarily potters' wheel types, paddle and anvil tech-

niques, and firing techniques. Their work forms the basis of comparisons between Indian and Pakistani potters' techniques in this monograph. Demont and Centlivres (1967) have published, in French, the most thorough outline of potters' techniques in Afghanistan, although most of their study was confined to the northeastern part of that country. Social and economic factors in the potters' lives, as well as techniques, are discussed, and a list of references is included.

Fischer and Shah (1970) include a potter among the craftsmen studied in one village in Saurashtra, India. This study thoroughly examines all aspects of this potter's craft and is particularly valuable for its verbatim recording of interviews with the potter, which give a warm and human insight into the potter himself as well as his craft. Various other crafts are included in their publication, as is a brief list of reference works. Yoshida (1972) gives some useful observations of ceramic techniques in Pakistan, Afghanistan, and Iran in a generalized work based on recent travels to pottery centers in these countries. A detailed recent study of glazed ware from Meybod, in Iran, has been published by Centlivres-Demont (1971). An extensive bibliography is included. All aspects of the potter's craft and economic environment have been included in this study. A very useful study of a limited area is that of Dhamija (1964), who outlines techniques of production of glazed ware in Jaipur, Rajasthan. This ware is distinct from any now produced in Pakistan.

The present monograph is intended as a beginning toward overcoming the almost complete lack of ethnographic data related to pottery making in Pakistan.

Methodology of the Field Research

One of the aims during field work was to cover the widest possible area of Pakistan, which immediately placed restrictions on the amount of time that could be spent in any one area. During 1971, therefore, the longest time spent at any one potter's workshop was about one week; in some cases no more than a day could be spent with a craftsman. This meant that the selection of craftsmen with whom work was to be done could not be as selective as possible.

The basis of selection was determined at several levels: First, earlier field surveys carried out by members of the Ancient Technology project had established those areas that would be most fruitful for research. It was known before 1971 that glazed ware was produced by traditional techniques in Quetta, Hala, Multan, Zakhel Bala, and Pabbi, and that outside of these areas there was little glazed ware of traditional significance being produced, except perhaps at Thatta, in Sind. The unglazed ware of Ahmedpur East, known locally as "Bahawalpur paperfine" or "paperweight" pottery, was known to be considered within the country as the finest unglazed ware. In addition, some data had been collected in several other centers where unglazed earthenware was produced. These centers where data was already available were selected for inclusion in the detailed studies during the 1971 field season.

Second, the project involved study of technologies other than ceramics; the 1971 field season itinerary was planned around areas where fruitful studies in these areas also could be made. Other studies in the Smithsonian Institution's traditional technology research program are reported by Godden (1975) where he presents data for boat building, gunsmithing, *bidri* and lacquer-work and has provided an excellent insight into the methodological problems of field studies of this type. Occasionally, then, the research team was in an area where potters were working, but where there was no previous data to indicate their working methods. In this case the selection of workshops for study began with an examination of wares for sale in local bazaars. Usually such an examination revealed types of ware that were most commonly available in that particular district, and it was a straightforward process to ask the shopkeepers where they had obtained the wares. This resulted in narrowing the production center down to a specific village. Occasionally, as was the case in Kohat bazaar, it became obvious that an unusual type of ware was being sold (in this case the ware from Kharmathu, which on initial examination appeared to be made from a salt (NaCl) containing body). In any case, the production center could be determined easily.

Knowing where production centers were located, either on the basis of previous surveys or on the basis of information obtained in the bazaars, the problem became that of selecting an individual craftsman with whom to work. Villagers were willing to guide us to the workshop of a potter, but first an attempt was made to determine the status of the potter among other potters in the village. As far as possible, we selected a craftsman whose name was given as a good craftsman; but this "status" question was not checked thoroughly. This was, however, easily verified by inspection of the pottery on sale in the local bazaars.

The most straightforward procedure was to obtain permission from the potters to watch them at work, to question them about their techniques, and to photograph them. Almost all potters readily agree to this request. A practical problem often arose when we were to study a particular potter and workshop

for several days. The craftsman could not interrupt his work schedule for this period without any form of compensation, so the question of "payment for services rendered" became an issue. It is undesirable to "buy" information, for obvious reasons. The problem was solved usually by reference to the fact that we wished to collect samples from the potter at the conclusion of the study, and that we would be willing to purchase them at market rates. Usually the problem was resolved when the potters understood that we had no intention of wasting their time and we were able to proceed on the basis of trust.

The question of reliability of field data must be examined briefly. In cases where techniques were observed by us with minimal interference of the normal working routine in a workshop, the question of reliability of that observation of that technique does not arise. The question of reliability primarily arose when "trade secrets" were questioned, the major area of doubt being the glazing techniques of glazed ware potters. Analytical studies have been used to check the field data obtained from interviews with potters and firsthand observations of the potter at work. In all major respects the analytical studies confirm the field data, which, therefore, have been reported almost in their entirety. Only those doubtful data have been removed, when it appears the information or question might have been totally misunderstood. In many cases there was no opportunity to check the sources of materials as stated by potters. These have all been included exactly as obtained in field interviews. Probably the main source of unreliability was the method of obtaining data by interview, utilizing various interpreters. As far as possible descriptions of processes given by potters through an interviewer were checked by asking the potter to demonstrate the process from beginning to end.

A catalog of all collections of Pakistani potters' materials, tools, and products now in the Department of Anthropology of the Natural History Museum of the Smithsonian Institution has been included as Appendix 1 (page 170). Thus, any of the analytical or experimental findings reported in this monograph are open to further investigation. Catalog numbers from Appendix 1 also are used in various parts of the text and may if necessary be identified and cross checked against the catalog. For consistency and brevity these catalog numbers carry the acronym "USNM" for the former United States National Museum in which they were listed (e.g., USNM 412,686).

Presentation of the Data

In recent years, archeologists have begun to use the findings of ethnographic research extensively, in order to refine the interpretations of their excavated material. The study of man's technological means of dealing with his physical environment has gained depth through studies of primitive surviving technology, in areas where primitive groups have remained relatively uninfluenced by the inroads of the latest technologies.

The value of such studies in archeological interpretation is too well known to merit discussion. Less obvious is the very rapid disappearance of traditional village crafts in many countries, as the work of craftsmen is replaced by the products of modern industry. Thus, there is an urgency to record the working techniques of the craftsmen while there still can be direct observation and discussion.

No attempt has been made to relate the observations and findings reported here to the archeological literature, despite the manifold temptations to do so. It was considered more important to make the ethnotechnological investigation available in as much detail as possible, so that firstly omissions and inconsistencies can be recognized and clarified in further field work, and secondarily the archeological analogy can be made in the future when such field studies with living craftsmen are no longer possible.

As a result, the data obtained from the observations and participation in field work have been reported in this monograph in as much detail as possible. This means that some workshops are discussed in much greater detail than others due to the length of time with a potter or the better cooperation of a particular informant; this inconsistency must be accepted for the sake of the fullest presentation of data.

Anyone who has become familiar with literature relating to Pakistan will be aware of an immediate problem: that of transliterations of languages of the region into a Romanized script, which give a phonetic rendering of the language in question. Transliteration of Pakistani languages into Romanized script intended for English-speaking readers has resulted in a confusing diversity of systems of translation. This confusion is partly due to the existence of many vowel and consonant sounds in Pakistani languages that have no equivalent for an English speaker. A transliteration of Urdu for English speakers is linguistically sound, but uses many symbols not found in English writing, and is, therefore, better suited to the use of linguistic specialists to whom the symbols can in time become familiar. Literature not specifically involved with linguistic questions has more com-

monly involved the use of standard Roman English script, modified for phonetic equivalence by use of a system of diacritical marks added to the Roman English letters.

In the present work a twofold approach has been taken, and hopefully this will be excused on the grounds of improved clarity. The names of cities, towns, and villages are given without diacritical marks, as they appear in the English language Oxford Atlas (1959 edition), because it is unlikely that names rendered as "Peshawar" or "Lahore" will cause any confusion. The names of smaller villages, not found on maps available to the writer, are also given without diacritical marks, both for the sake of internal consistency of presentation of place names, and also because the presentation agrees with local Anglicized renderings used within Pakistan and familiar to any traveler in the country. For example, a village near Lahore is described in this work as "Shahdarah"; with diacritical marks added this would become Shāhdarā. Locations of smaller villages are given in the text.

In a few cases English loan words derived from other languages, but with a clear meaning to the English reader, are given as they usually appear in English; examples of this are "bazaar" and "hookah." The names of people have also been rendered as they would normally appear in Anglicized form.

The record of the potter's terminology in this monograph is far from complete. Only the names for which consistency of transliteration is possible are included. For this reason many Pashto terms, incorporating sounds for which conflicting sounds in Urdu commonly have the same symbol, have been excluded. Some of the symbols used in this monograph, and their approximate equivalents, are as follows: long vowels are shown as *tīr*, rhymes with "beer"; short vowels have no symbol, as *rang*, rhymes with "bung"; retroflex consonants are indicated by dots under the letter, as *loṇ, ṭok* (a "soft" consonant); implosive sounds of Sindhi and Multani are underlined, as *garaṇu;* nasal vowels are indicated by a tilde, as *bhañaṇu,* the aspirated consonants *sh, gh, kh* are represented as digraphs, pronounced as gutturals; and "c" is similar to the "ch" in "church"; ᶜ equals a glottal stop as in Niᶜmatullāh.

A few additional comments about the organization of the report should make it easier for the reader to select what interests him the most, or to provide the specialist with an outline of just what is to be expected throughout the entire monograph. The arrangement of the first major division of the monograph into the study of the techniques of pottery making as observed in the various towns from field research follows the various towns, valleys or regions within the major present-day political provinces. Repeated in each chapter are the same outlines of details for easy reference and comparison of the data; that is, a brief introduction about that particular area, the potters, the importance of the area, followed by a discussion of the tools and equipment of the particular potter or potters of that area, how the materials are gathered and prepared and what the particular potter says about them from his experience or actual basic "scientific" knowledge, and then the forming of the various types of vessels and the finishing techniques of the vessels' rim, lips, base and surfaces, with decoration mentioned if involved. Each section is closed with details on the firing process and the types of pottery vessels produced. Since techniques varied considerably between unglazed and glazed wares, these categories were followed as a further breakdown in the arrangement of the data in this section.

This detailed ethnographic presentation has its significance beyond recording the traditional pottery craft in Pakistan. It also lays the foundation for the second major section of the monograph. All the techniques are summarized and analytical studies of a highly technical nature were applied to the clay, tempering materials, the slips, the pigments, and the glazes. From controlled laboratory experiments in kilns, the firing techniques were studied in great detail. This application of highly sophisticated modern laboratory techniques used in modern ceramic engineering to the traditional pottery crafts has not been conducted very frequently. The results are so rewarding that it is hoped the ethnologist, the archeologist, the professional potter, the interested scholar in traditional crafts, who might not have an extensive chemical, geochemical, or physical chemical background, will not be driven off, but instead they will delve sufficiently far into the monograph to discover these analytical studies and to appreciate their fundamental contribution and the possibility of their opening up new approaches to the study of traditional crafts.

In the six appendices a variety of miscellaneous data is assembled, which is fundamental to the monograph as a whole but should not burden the major body of the report. The catalog of the collections is sufficiently detailed to allow any interested person, whether ethnologist or potter, enough information to write to the Department of Anthropology, National Museum of Natural History, Smithsonian Institution, to obtain photographs and additional information of the subjects, etc., by using the catalog numbers. A translation of the Multan potter describing his tech-

niques of pottery making is very interesting and technically sound, and the potter's book of instructions handed down from generation to generation gives a time depth to traditional techniques that was worth recording. Sintered plant ash is such a specialized topic that it receives full treatment by itself to include the chemical, botanical, and historical information. For those specialists interested in the detailed chemical analysis of the fired glazes, the electron microprobe data is compiled and commented upon by the Smithsonian geochemist J. Nelen. For the ethnologist interested in folklore and its relationship to pottery making, the unpublished legend of Soni and Mahiwal is included. The glossary should prove useful to those unfamiliar with some technical terms in pottery making, as well as local terms in Pakistan from both Urdu and Pashto.

Plates are by Owen Rye, except as follows: Photographers in Pakistan were Elaine Godden, Donald Godden, Charles Walton; artifacts in the collections of the Smithsonian Institution were photographed by Vic Krantz of the National Museum of Natural History, Smithsonian Institution. All photographs are from the files in the Department of Anthropology, Smithsonian Institution.

Plates by Donald Godden: 34*a-b*, 47*a-d*, 50*a-j*, 51*a-d*, 52*a-e*, 56*a*, 62*c,e*, 63*a,b,f,g*, 64*a-b*; Elaine Godden: 27*a-d*, 28*a-e*, 29*a-d*; Charles Walton: 13*e*, 14*b-c*, 16*c-d*, 17*a-i*, 20*e*, 30*c*, 48*a-d*, 55*a-h*, 56*b-f*, 57*a-f*, 58*c-h*, 59*a-b*, 61*c-d*, 63*c-d*, 64*c-e*, 65*a,c-d*, 69*a-c*; Vic Krantz: 7*a*, 11*a-b*, 12*a-b*, 20*a-d*, 32*a,b,d,e* 35*a*, 37*d*, 40*a-c*, 42*a-c*, 43*a-c*, 44*a-d*, 45*b-c*, 49*a-e*, 53*a-b*, 54*a-c*, 58*a-b*, 67*a-b*, 68*a-e*, 74*b-e*, 75*a-d*, 76*a-b*, 77*a-g*, 78*a-f*, 79*a-g*, 80*a-d*, 81*a-m*, 82*a-b*.

Field Studies of Unglazed Ware

BOMBORET VALLEY, KAFIRISTAN, NORTHWEST FRONTIER PROVINCE

Of all the potters included in these studies, Noor Khan works in the most remote and inaccessible area. In 1971, Bomboret could only be reached from the Chitral valley on foot. This entailed travel by jeep from Chitral to Ayun, the roadhead at that time, and then a walk of some 15 miles from Ayun to the Bomboret Rest-House at the head of Bomboret valley. Two routes could be used: In late summer the direct route along the Bomboret River was passable, but in May this route was closed because of the river flooding due to melting snow from the previous winter. Thus, an alternative and more tiring route over the mountains had to be used. All requirements, apart from food, had to be carried in by porters or donkeys. Accessibility was being improved, however, by the construction of an access road from Ayun, scheduled for completion in late 1971.

Bomboret is one of the three valleys that constitutes the present Pakistan Kafiristan, the others being Birir and Rambur. Birir has had road access for some time; Rambur is still the most remote of the three and is best reached by walking from Bomboret. The total area of Kafiristan now is only a fraction of that occupied by the Kafirs before this century (Jones, 1966). Since the beginning of active conversion of Kafirs to Islam in the 1890s, the number of true Kafirs (infidels) has declined very rapidly.

Apart from the immediate access to the Chitral valley, the occupants of Kafiristan also have access to Nuristan, the culturally related area across the border in Afghanistan. A number of people interviewed in Bomboret, including the potter, had emigrated from Nuristan in recent times.

The Kafiristan valleys have in the past been virtually self-sufficient economically, including the limited production of pottery. Recently, under Pakistan government control, access to the outside world is increasing. A major factor in this is the introduction of a year-round airline service to Chitral. The Lawarai Pass road to Chitral, open for some six months of the year, is also important to trade. Many goods from the larger centers, such as Peshawar, can now be imported into Chitral. Only some of these reach Bomboret. Goods such as printed cloth, aluminum utensils, and some foodstuffs are available in very small bazaars in Bomboret. These goods have not yet become an important factor in the economy of the valley since the medium of exchange is still largely barter. So it may be said that, although the potential for import of goods is established, the valley of Bomboret is still basically self-sufficient in goods.

The potter still finds limited demand for his work, which, it appears, will be threatened by the import of aluminum vessels in the not-too-distant future. The market even now is small. Aluminum pots are widely used such as for cooking vessels. Less commonly used are iron cooking pots, which are imported from Nuristan. Goat skins are widely used for the storage of water and milk. Wooden bowls and wooden ghee-pots are common. Some glass and used tin-plate containers were seen in use. The use of these vessels made from other materials means that the potter fulfills a very limited demand for vessels. The fact that the potter can only produce his wares for a limited period during the year places further restrictions on his production. He can only work during the summer months of May, June, and July; during the winter the valley is completely snowed in and the people and animals remain indoors, as much as possible.

Noor Khan makes cooking pots, small drinking vessels, milking pots for both goats and cattle, large storage pots for milk and water, and grain storage pots for use inside the house. Of these the greatest demand is for grain-storage pots. During the winter months grain is stored in large containers made from slate slabs, in storehouses apart from the living quarters. Smaller amounts of grain are stored inside the house itself in grain storage pots.

Noor Khan is Sheikh (that is, formerly of the ethnic group known as "Kafir," the name given to those who were once Kafir, then later converted to Islam), but he makes pottery for anyone in the valley who orders it, including Kafirs. Even so the total number of vessels made in a year is very low, about 40–50 vessels for a total population of about 1200

people. He said that this number has remained constant for some time, despite increasing use of aluminum utensils for some purposes.

Pottery vessels are paid for by barter in most transactions. Those to be sold are filled with maize twice, wheat one and a half times, barley three times, and corn three times; this amount of grain is then taken by the potter in exchange for the vessel. Pottery vessels are made on order only, never otherwise, so the potter has no marketing to consider.

Noor Khan learned his pottery techniques from his father, a potter and carpenter in the Nuristan village of Shud Gul. Noor Khan was proficient in his craft before he moved to Bomboret. It was not possible to determine if there was any continuity of pottery tradition within Bomboret itself, except insofar as pottery vessels, which had been in use for a long period of time (perhaps 20–30 years) were very similar in appearance to recently made ones. Noor Khan indicated that his own pottery techniques are still very similar to those used in Nuristan; the tools are similar with the exception that he uses a stone for grinding quartz that is to be used as tempering sand, whereas in Nuristan a mallet of very hard wood is used. Like his father, Noor Khan also has woodworking skills; when not making pots he makes wooden water channels for use in the irrigation of the fields.

Noor Khan said that he is the only potter in the three Kafiristan valleys, and that some of his orders are received from the other valleys, very rarely from Birir but more often from Rambur. There appears to be generally more interchange with Rambur than Birir.

There is no family involvement in the potter's work, except that his son helps him to gather clay. There is no evidence of women being involved at any stage of the process, an uncommon situation for a Pakistani village potter. His work situation is uncommon in another respect also; he has no fixed workshop, whereas most village potters combine their home and workshop. The architecture of his village (Sheikhanderkhel), however, is of a style which would make it very difficult for a potter to combine the two functions of dwelling- and working-place. All the houses of the various inhabitants are combined in one stone and wood structure, with common walls and five or six floors on different levels. That is to say, the village structure is multi-story, with levels not consistently one floor apart, but "split level." New additions begin at ground level, where the surface slopes unevenly, and the minimum of leveling or building-up foundations has been used. Thus, the upper levels are determined by varying base levels. Individual dwellings are reached by wooden stairs and passageways through the structure. The difficulties of a potter attempting to operate within such a structure are obvious when it is considered that all materials for pottery making must be taken inside, and all pots must be taken outside to be fired.

Although not having a workshop as such, Noor Khan has a fixed working area outside the blacksmith's shop, about 400 meters from the Sheikh village. Because pots are only made during the warm summer months, and because the potter has no large or fixed equipment, such as a potter's wheel, this area is quite adequate for his purposes—indeed, it has some advantages. Pots can be dried in the shade of nearby mulberry trees, or if necessary inside the blacksmith's shop away from drafts. The blacksmith's forge provides a source of heat for preheating of pots just before firing, and in the potter's other occupation as wooden water channel maker, the blacksmith's shop is a convenient place for storing, repairing, or sharpening his tools. Probably equally important to all these other considerations is a social advantage. Because the potter's attitude to work is extremely relaxed, and this area was a meeting place for discussion among men of the village, the potter can carry on conversations with his friends while working.

Tools and Equipment

Turntable and Base (Plate 1*a,b*).—Turntable approximately circular shape, average diameter, 61 cm. Carved from deodar wood in one piece (which has subsequently split and was repaired by inserting two pieces of deodar in trenches running across the grain). On the lower surface is a cylindrical boss, left during the carving; boss average 10 cm diameter and 4 cm high. In the center of the boss an iron point is inserted; this point acts as the bearing around which the turntable revolves. The base is a rectangular piece of deodar 36 by 23 by 4.5 cm thick. In the center of one (upper) face a circular socket 11 cm diameter by 1 cm deep is carved. In use the boss of the turntable is inserted in this socket, where it is free to revolve on the iron bearing point, but is restrained from inadvertant lateral movement.

Clay Digging Tool (Plate 2*b*).—A general agricultural implement in wide use in Bomboret. Head is hand-forged mild steel, overall length 21 cm; circular-slotted to receive the wooden handle, length 54 cm, diameter 3 cm. The single point is sometimes sharpened to a chisel edge so that the tool can be used for wood working.

Sieve (Plate 1*c*).—Average diameter 37 cm, height 8 cm. Made by the potter. A wooden lath 0.5 cm thick is bent to form a cylindrical frame, and tied

with leather thong passing through holes bored with an awl in the overlapping ends. This forms the frame of the sieve. The untanned skin of a young goat is then wetted and stretched over the frame. When the leather dries, hair is scraped off with a sharp knife, and holes punched through the skin with a steel punch. The diameter and shape of the holes varies; average aperture is 3 ± 0.5 mm variation.

Iron Dish (Plate 1*d*).—Dish with two circular iron handles, attached by rivets. Diameter 47 cm, overall height to top of handles 21.5 cm. Normally used as a cooking pot, imported by the potter when he emigrated from Nuristan.

Pestle (Plate 2*c*).—Double ended, overall length 48 cm, diameter 10 cm. Both ends rounded so that either end can be used interchangeably. Central portion (12 cm long) trimmed down to provide a central grip; ends of unequal length (one 20 cm, other 16 cm). This type of pestle is common in many areas of the Northwest Frontier Province, used for many domestic grinding operations, such as grinding of spices and salt.

Crushing Stone.—A rounded river pebble (dolerite), used for rough crushing of quartz stone, to be used as a nonplastic addition to body; 11 cm diameter on largest axis.

Paddles, sometimes called beaters (Plate 1*e*).—Small paddle: length 37 cm, maximum width of blade 2.9 cm, thickness of blade tapering from 1.7 to 0.4 cm. Carved by the potter from deodar wood. Large paddle: length 40 cm, width of blade 7.5 cm, thickness of blade 1.8 cm, tapering to 1.2 cm at tip. Carved from deodar wood by the potter, using an adze.

Water Container.—The potter uses any convenient vessel for this purpose; during the demonstration of his techniques for this study he used aluminum vessels.

Decorating Tools.—The potter has four tools, all carved from deodar wood, for applying impressed decorative patterns. Only the ends of the tool are used. One is sharpened to a point; one has a triangular point (equilateral, 0.5 cm side); one has flattened, rounded ends, and the remaining one has a chisel end approximately 3 cm wide.

Wooden Batt.—The base on which pottery vessels are formed and moved while the clay is still soft. Noor Khan used a wooden window shutter for this purpose (37 by 38 by 3 cm), because the preparation of a piece of deodar wood of these dimensions requires work with an adze, and the shutter is not required for his house during the summer. The shutter has hinged extensions attached at the extremities of one side; these fit into slots in the window frame when the piece is being used as a shutter on his house.

Materials Gathering and Preparation

The body used by Noor Khan is based on two materials: clay and sand resulting from the crushing of quartz river pebbles. Both materials are gathered by the potter as required and no reserves are held. The clay is a residual clay from the weathering of slate in situ. The dark slate outcrops in the mountains around Bomboret valley. According to the potter, clay extracted from any site where the slate is extensively weathered is suitable for pottery making. For convenience he gathers clay from the mountainside nearest to his work area—not from a single specific site, but always in the same general area. The area was chosen because the clay appears similar to material that he used in Nuristan. From his workshop the area is about 150 m up the steep mountainside, reached partly by using a poorly formed track and partly by climbing across slate outcrops. The potter selects an area (Plate 2*a*) where the clay has been sheltered from rain, underneath a ledge of rock. He digs about 10 kg of mixed clay and slate fragments, and allows the lumps to fall onto a ledge near his feet. He then hand-sorts the material, tossing rejected pieces of slate, tree root, and other organic material down the mountainside. The remaining clay material is placed in a goatskin bag; the potter's son assists in this operation. Then more material is dug and sorted and placed in the bag until sufficient material is accumulated. When full, the bag contains about 25–30 kg of clay. If the potter requires more clay he will fill up more bags, up to a maximum of 75 kg, which is not considered an unreasonable load in that area, even in difficult terrain. No attempt is made to cover or otherwise protect the clay deposit after sufficient material for immediate use is dug.

The stone to be crushed for incorporation in the clay body is selected from pebbles in the bed of the Bomboret River. Metamorphic rock predominates in the area; river pebbles in the area where the potter selects his material appear to be mostly acidic, predominantly gneisses, some very coarse grained. Other gradations between gneisses and schists, containing coarsely foliated muscovite and quartz, were observed. The rock selected by the potter is very quartz rich, with only a little muscovite. He stated that he selected this rock because it is much easier to crush than reef quartz and more readily available. His answers to questioning indicated that he is aware of the distinction between quartz and other minerals, and that he is selecting the mineral quartz rather than a "rock" for addition to the body. He also pointed out that although sand is available in the river bed, he does not use it because the pots would break. He had

tried using the sand when he moved from Nuristan, but has reverted to methods similar to those he used in Nuristan when his experiments were unsuccessful. The sand that he had experimented with contains a high proportion of slate pieces and dark minerals.

The pieces of stone are carried back to the pottery, a distance of some 300 m. They are crushed on a piece of slate, a large slab (1.5 by 1 m) (Plate 2*f*). First the large pieces are broken up, using a dolerite river pebble as a hammer. The crushing is continued until all pieces are less than 1 cm, which means that most of the material is finer than 0.5 cm. The potter then uses the dolerite pebble with a rolling rather than a pounding action, to grind the pieces finer. Some of the coarest pieces are then set aside, and the remaining material sieved. The material passing the sieve is almost all finer than 0.3 cm, but with some coarser pieces because of varying sieve apertures.

When a suitable amount of sand is prepared, most of it is set aside, leaving only about 0.5 kg spread over an area of 0.5 m diameter. A pile of clay is then spread over the top of the sand. The potter removes any pieces of slate or organic material remaining in the clay, by hand-sorting, at the same time forming the clay into a low conical pile. Then, using a heavy double-ended wooden pestle he begins to pound the clay in the center of the pile. This breaks up any lumps of clay and pieces of slate. Material is moved by hand from the rim of the pile to the center so that all the clay is eventually crushed, and the sand evenly mixed in. When the crushing is complete, the sand/clay mix is again sieved, to remove the last remnants of slate and organic material.

The potter prepares only enough body for the number of pots he intends to make in any one working session. The body is mixed on the same slate slab that is used for crushing and grinding quartz. Sieved, mixed clay/sand is placed on the slab and formed into a conical pile. The center of the pile is then hollowed, and water poured into the hollow. The potter then begins moving material from the edge of the pile into the water in the center, so that all the clay becomes evenly wetted. He then begins to mix the clay by squeezing material between his fingers, beginning at one side of the pile and working gradually across to the other. As the mass is mixed he changes to a kneading action, using the heels of his hands, moving away from his body. The clay is finally rolled into a lump. The lump (only part is used if a larger batch of material is prepared) is then transferred to an iron dish, into which some sand is sprinkled to prevent the clay from sticking to the dish. The lump of clay is flattened into the dish and the tempering sand added by sprinkling it over the clay, and working it in by rough hand-kneading. The potter stated that the total amount of sand added to the clay is one part to seven parts of clay, but some variation would be expected from batch to batch because the proportions are determined by judgment rather than measurement.

Finally, the body is prepared for use by kneading, using a method not seen anywhere else in Pakistan. When the sand is mixed in by hand, the potter begins pounding the body in the dish with a large double-ended wooden pestle. He continually moves the material from the edge of the dish to the center to insure even mixing.

The total time for all the above operations was about four hours. The amount of material was somewhat smaller than the potter usually prepared, since this was a special demonstration for our study, According to the potter the time taken for gathering materials and preparing the usual amount (40 kg) of body is about six hours. The potter explained that he does not work to a precise schedule, and this is in keeping with his relaxed attitude during the study; he often left his work for conversation with friends who called at his workplace.

Forming and Finishing Techniques

The potter demonstrated the making of two pots, a cooking pot and a water or milk pot (Plate 6*c*). First, he sets up the turntable on a level area of ground. He places the base down first and then locates the turntable boss in the base socket so that the turntable revolves freely. He arranges all the necessary tools nearby so they can be reached without moving from the turntable. The iron dish, containing kneaded clay, ready for use, is placed immediately to his right in the early forming stages. A wooden batt is placed on the turntable so that its center coincides with that of the turntable. A light dusting of sand mixed with dried powered clay is sprinkled on the batt to allow easy removal later. Asked why clay is mixed with the sand, the potter said that his only reason is that his father had taught him to work that way. The clay has the effect of removing some water from the plastic clay in the base of the pot, and perhaps gives a finer surface than sand used alone.

About 1.5 kg of body is then formed into a ball, which is placed on the center of the batt. This ball of clay is patted down, using the heels of the hand, to about 20 cm diameter and 2 cm thick at the outer edge; the thickness at the center is much greater, about 5 cm (Plate 3*a*). The blows are directed slightly off-center so that the turntable revolves a little each time. Using the heel of the hand, the potter then

moves clay from the center of the disc-shaped lump toward the edge, to form a thick rim (Plate 3*b*) which is then turned up slightly. The overall diameter is then about 35 cm, and the turned-up rim about 3 cm thick.

The potter then begins to work with both hands, fingers inside and thumbs outside the vessel, pinching and lifting the rim of the base. This forms the lower wall of the pot. The turntable is turned slowly with the right foot during this operation (Plate 3*d,e*). The wall is raised to a height of about 8 cm in two stages: in the first the rim is left thick, while in the second the thick rim is thinned and lifted by pinching. This leaves a flange of clay around the central portion of the wall. The flange is then smeared over with the right hand thumb, with the left hand supporting the inside of the wall of the vessel as the outside is smoothed.

Then with the fingers of the left hand held firmly together to form a flat surface, supporting the inner wall of the vessel, the potter uses a large wooden paddle to smooth and shape the outer wall. This further raises the height of the wall slightly (Plate 3*f,g*). After these operations the rim of the semi-completed vessel has become irregular, so the rim is cut off with the tip of a small pointed wooden tool (Plate 3*h*). The outside of the vessel is smoothed and refined by rubbing with the flat side of this wooden paddle.

A further lump of clay of about 3 kg is then kneaded by taking the lump in both hands, palms down, and squeezing the fingers into the lump so it is almost divided into two portions. This U-shaped piece is then turned through 90°, the two raised portions are folded flat, and the process is repeated nine or ten times. The lump of clay is then formed into a coil (Plate 3*i*), which is shaped by squeezing the clay between both hands so that it hangs down vertically as it begins to form; the elongation is aided by the mass of the clay.

The coil is then added to the top of the vessel. Its original length is slightly less than the circumference of the vessel, so that as it becomes stretched during the joining it expands to the circumference. The potter then unites the coil to the outside (Plate 3*j*), supporting the inner wall with both hands while his thumbs smear the coil down the outer walls (Plate 3*k*). He then bonds the new material on the outer wall more firmly by smearing with his right thumb. During these operations the turntable is slowly revolved; the potter either revolves the vessel itself slowly during the working or revolves the turntable itself with one foot.

When the coil is thoroughly bonded to the vessel, Noor Khan again smooths the outer wall by beating it with a large wooden paddle, while supporting the inside wall with the fingers of his left hand. The paddle is used with a slightly upward action rather than directly perpendicular to the walls of the pot; this is a more efficient way of raising the height of the walls, as well as thinning and smoothing them. After some beating, the rim, still containing most of the clay from the added coil, is thinned and raised by pinching the clay between fingers and thumbs. When the wall thickness is evened by this process the beating is again resumed. After this beating, the vessel reaches the form of a truncated cone measuring about 25 cm base diameter, 15 cm diameter at the top, and a little less than 15 cm height. This conical shape gives the semiformed vessel great stability in the plastic state, stability which is further aided by the stiff working consistency of the clay.

The next stage of forming is to turn over the rim of the vessel using a small wooden beater (Plate 4*b*). The potter holds the outside of his little finger, palm up, against the side about 3 cm down from the rim. Using the paddle with his right hand he beats against the inside of the rim and gradually folds it outward. The edges are finally finished off by gentle beating.

At this stage it is decorated (Plate 4*c*). Two pairs of horizontal grooves are incised with the point of a sharp wooden tool by holding the tool against the vessel wall as the turntable is revolved. A pattern is impressed between these lines using the point of the wooden tool side-on. This gives a triangular impression which is deeper at the apex than at the base of the triangle. The pattern is in one horizontal band around the vessel, separate impressions equally spaced about 2 cm apart. Because the turntable is revolved slowly and intermittently, these decorative lines and patterns tend to be irregular. With the upper part complete, the vessel (still with the wooden batt attached) is placed aside to dry to the leather-hard state. A piece of damp cloth is wrapped around the base so that the upper walls and rim dry more quickly than the base. The vessel is dried for about one hour on a warm day. During the course of normal work the potter then begins work on the next vessel, and has the next vessel to this same stage by the time the first is ready for further working.

There is only one basic difference in technique between the two vessels made by Noor Khan for demonstration. The cooking pot has straight sides; therefore, during the operation of beating the wall with a wooden paddle the potter supports the inner wall with his left hand. In the case of the water pot, however, the walls and base are one continuous rounded shape, which necessitates the use of an anvil

to support the inner wall of the pot during the beating. Noor Khan uses a carefully selected rounded river pebble as an anvil (Plate 4*e*).

When the upper walls of the cooking pot dry to a leather-hard state, the bottom is at a very stiff plastic stage of drying and is rounded by the paddle and anvil technique (Plate 4*d*). It is then smoothed by light burnishing with one face of a large wooden paddle.

Vessels finished to this stage are usually dried outside in the shade first, and then dried inside overnight before firing.

Firing

The firing technique of Noor Khan is distinct from any other observed in Pakistan. Vessels are fired in a small stone-lined pit. The pit-kiln is not a fixed structure but is rebuilt for each firing, unless two sequential firings involve a similar number of pots of similar sizes. It is built in the same place each time, a cleared, slightly domed area of ground about 3 m diameter. The center of the firing area is excavated (Plate 5*a*) with a pick, the soft earth being removed by hand and placed in a pile near the hole. Some loose pieces of slate found during the digging are set aside for later use. For the observed firing, the hole was about 1 m diameter and about 0.5 m deep.

When the hole is excavated, the sides are lined with pieces of slate, which vary in size, but average about 15 cm square by 5 cm thick (Plate 5*b*). Pieces are laid around the circumference at the bottom of the hole, then the side walls are lined with loose earth originally from the hole. The slate wall is built up about 15 cm above the original ground level. Loose damp earth is packed against the outside of this portion so that the final kiln appears as a slate-lined circular hole in a dome-shaped mound of earth.

By this time the vessels to be fired are dry and ready for preheating before setting in the kiln. The preheating is quite unusual. A small fireplace is used (Plate 5*c*). A large slate slab is placed over the fireplace on either side, leaving a central gap of about 15 cm immediately over the fire itself. The vessels are placed upside down over this gap. A very small fire is lit using small pieces of blue pine (*Pinus excelsa*), a standard wood used for fuel in Bomboret. (As well as its use for both cooking and domestic heating, it is commonly used—in the form of small slivers about 1 cm square—as a lighting source because of the high content of volatiles which make it burn quickly with a bright flame when burned green. See Parker, 1918:540).

In an hour, the fire is built up until it is burning quite strongly and flames are playing around the rim and sides of the vessels. During this preheating period the kiln is prepared to receive the vessels so that there is a minimum delay between removing the vessels from the preheating flame, and beginning the firing of the kiln.

The primary fuel for the firing is the bark of old blue pine trees—rough and deeply fissured rather than smooth like the bark of younger trees. The pieces of bark are about 3–4 cm square by 10–15 cm long. To prepare the kiln for firing, a layer of slate pieces is placed on the floor (Plate 5*d*) and covered with a layer of pine bark about 10 cm deep.

The kiln is then ready for setting the vessels. These are allowed to cool enough for handling after removal from the preheating flame. It was observed that the heat was intense enough to partially fire the pots. The potter was asked why this degree of preheating is necessary, but his only answer was "otherwise they will break in the firing." This does not explain the need to preheat to such a high temperature. The explanation may be deduced from his answer to a different question. When asked why he used pine bark as fuel rather than pine wood, he explained that the bark burns with a very hot, short flame so that heat is localized and retained in the kiln, whereas the wood burns with a long flame and much of the heat is lost outside the kiln. The quick, intense heat of the burning pine bark raises the initial temperature very quickly, and vessels that are not preheated cannot be expected to survive without cracking. The method employed—slowly preheating to a temperature estimated at 500°C (a red glow just begins to appear on the rims of the pots in dim light)—removes all free water from the pots, and is also expected to remove some of the water of crystallization from the clay minerals. These two sources of water provide the key to explaining many cases of cracking of pots due to heating too quickly in the early stages of a firing. The water, under these conditions, cannot be removed quickly enough through the fine pores of the clay being fired, and so is converted to steam with sufficient pressure to shatter the vessel. Noor Khan's method of eliminating this water by preheating is one method of insuring that the true firing is carried out quickly, with a high rate of temperature rise, without shattering the pots.

The vessels are placed in the kiln, resting on the bottom layer of pine bark fuel (Plate 5*e*). They are placed upside down, inclined at an angle of about 45° to insure even heating of both the interior and exterior. Pieces of pine bark are then packed tightly around the vessels (Plate 5*f*) and in the bottom of the kiln so that the final setting of fuel appears as a dome,

projecting above the top level of the kiln. This dome of bark is then covered with pieces of slate (Plate 5g), arranged in such a way that an opening is left at either side of the kiln to allow the insertion of slivers of burning pine when the kiln is ignited (Plate 5*h*). These slivers are inserted toward the base of the setting, and the bark ignites quite readily. As soon as the bark begins to burn, the gaps at either side of the kiln are covered with pieces of slate. The total time from the beginning of preheating of the vessels to the actual lighting of the kiln is a little less than two hours. The bark fuel is consumed and the firing completed in another hour and fifteen minutes. White smoke is produced from the kiln for almost the whole of this firing time, and the fired vessels show only minor evidence of carbon staining. Occasionally, during the burning of the pine bark, flames appear through gaps in the slate covering the kiln, but basically the fire is well contained by the structure. No further fuel is added at any stage after the bark is ignited.

The kiln is left to cool overnight after the firing, which takes place late in the afternoon. When the pots are removed the next morning by removing the covering pieces of slate, a light deposit of ash shows that fuel combustion was complete, despite the apparent limited access of air. The kiln is left just as it appears at the end of firing, to be rebuilt before the next firing according to the size and number of vessels to be fired. According to Noor Khan, the two vessels he made to demonstrate his techniques are not unrepresentative of the number he might have in a normal firing, since orders are usually limited. His production never amounts to more than 30–40 pottery vessels per year, usually in batches of only two to five pots.

CHITRAL, NORTHWEST FRONTIER PROVINCE

Pottery making is not common in the Chitral valley. Only a few potters work there, and those only in the summer; in the winter heavy snow hampers movement and makes firing impossible. The pottery is very coarse and not of good quality, in terms of either durability or appearance.

In summer, some pottery is on sale in the Chitral bazaar, but the quantity is very limited. This pottery is made at the old Summer Palace of the Mehtar of Chitral; the Summer Palace is about an 8-kilometer, difficult, uphill march from Chitral town. The potters come from Madak village in the Mastuj area of the upper Chitral valley, where they are normally farmers. They move to the Summer Palace area when threshing is finished in Madak, and work as potters for only two months of the year—September and October. The Summer Palace location is chosen because clay and wood for fuel are both readily obtainable, and there is a ready market for their wares in Chitral town.

Of some 20 villages visited in the Chitral valley, only one had permanent potters, the village Seen, located 10 kilometers north of Chitral on the Garam Cheshma (Hot Springs) road. There were two potters (*tooṇj korāk*) in this village, one of whom was observed at work and interviewed.

Mehrab Shah, about 70 years old, began learning to make pottery at the age of 16. His father was not a potter, so his craft was learned from an old potter of Seen village. He said that the types of pottery he was making in 1971 were identical to those being made 50 years ago. Because his sons were not interested in becoming potters he was teaching two young men of the village on an irregular basis. Mehrab Shah is a farmer as well as a potter, with half an acre of land. He makes pottery only during the summer months, on order only. Orders are received not only from Seen, but from other nearby villages, including Mogh and Garam Cheshma. These orders are usually received between May and August, and amount to an average of only 50–100 pots per year at maximum; in some recent years his output has been less than 50 pots per year, so that even during the summer he needs to concentrate on his farming rather than on pottery making. In 1970 he had only two firings, each producing about 40 usable pots from a total setting of 50 in each (that is, 20 percent firing losses). This represents a total of only three weeks work as a potter in one year. The demand for his wares is decreasing as aluminum vessels become more readily available, since the price of aluminum vessels is competitive with that of the pottery and the pottery is less durable. Most of his pots are sold on a barter rather than cash basis, being traded for grain. This means that his market is basically among the poorer farmers in and around his village.

Mehrab Shah does not use a potter's wheel, so no part of his workshop is fixed. He always makes pottery in one area enclosed in the yard of his house, where shade from both a veranda and a mulberry tree is available. When not in use his pottery tools and equipment are stored in one corner of the ve-

randa, occupying an area of less than half a cubic meter of floor space.

He works alone unless his "apprentices" assist, or another young boy of the village who is a friend of his comes to help with carrying the pots around. The assistance of this boy is especially enlisted when a firing is imminent, since the bonfire area is some 300 m from the house and all pots for a firing have to be carried to and from the site.

When the pots are ready they are distributed to customers—some come to Mehrab Shah's house to collect them, others await delivery by the potter. Most of the pots are exchanged on a barter basis, by filling the pot with grain: once with wheat, or once with maize, or twice with unthreshed rice. The customers take away the pot and the potter keeps the grain. The same barter values are used by the Madak potters for their vessels. Prices in rupees vary according to the bargaining, with a range from 12 rupees for a large storage pot to two rupees for a small pot. Considering the local economic conditions these prices are relatively high.

Tools and Equipment

Mehrab Shah has very few tools for specialized pottery use, in keeping with the overall directness and simplicity of his techniques. The following were recorded:

Clay Preparation Dish (Plate 7*e*).—Wooden, hollowed from a tree trunk. Maximum width 64 cm, maximum length 81 cm, interior depth at center 19 cm. This dish is used for wetting the clay before use.

Paddles (Plate 79*b,c*).—Smaller: deodar wood, 33 cm overall length, maximum width of blade 7.2 cm, thickness of blade 1.4 cm. Larger: Overall length 39 cm, maximum width of blade 6.5 cm, thickness of blade 1 cm. These paddles were carved by the potter.

Anvil (Plate 80).—A river pebble about 10 cm diameter (diameter varied slightly), thickness 3.9 cm. The potter has other anvils, all rounded pebbles collected from the nearby Chitral River, of a basaltic rock type, ranging from 7 to 11 cm in diameter.

Hoops (Plate 7*a,b*).—Made by twisting together two or three willow (*Salix*) twigs. The potter had ten of these of various diameters ranging from 21 to 83 cm.

Slate Slabs.—On the floor of the working area, each slab about 1 m long and slightly less in width. These are used as benches for kneading, for rolling out coils of clay, or for keeping plastic clay or pots off the ground to avoid entraining pieces of unwanted grit.

Sieve (Plate 7*c,d*).—Wooden frame 29 cm width, 47 cm length, with sheet metal nailed on. Sheet metal punched to give sieve apertures ranging in diameter from 0.5 to 0.7 cm. The potter makes his own sieves. Formerly, before sheet metal was available, he used leather sieves—pierced leather stretched over a wooden frame.

Cloth Covered Hoops.—Two hoops similar to those described above, but with cloth wound around the willow. These are used as a support for the round bottomed pots during operations when they need to stand upright (Plate 9*d,e*).

Water Dish and Cloth.—A small earthenware dish used to hold water for use in forming operations, and a piece of cloth for wiping water onto pots or for smoothing.

Materials Gathering and Preparation

According to the potter, the clay deposit is some distance from the village, in nearby mountains. Twenty seers of clay can be obtained in one trip if the potter leaves early in the morning and does not return until late at night. The clay in use contained many fragments of slate, suggesting that the deposit is a residual clay, formed in situ by the weathering of slate. According to the potter the clay is obtained from small pockets at the site.

The coarse lumps of clay were left out in the potter's yard to dry in the sun, then were broken into finer pieces by beating with a stick. The finer fraction was then sieved using a perforated sheet-metal sieve. The coarse fraction received further crushing until all the material was reduced to suitable size to pass through the sieve.

This clay is used without admixture as the body; no sand or other nonplastics are added. Only small amounts of plastic clay are prepared at any one time—about 5 to 10 kg. Since the clay is made and used on the same day, the amount of plastic body prepared is dependent on the number and size of pots to be made on that day. The dry, crushed clay is placed in a large wooden dish and wetted with the minimum amount of water necessary to give plasticity. It is then left for half an hour until the water thoroughly penetrates the clay. The material is then kneaded. This is done by removing the body from the wooden dish, roughly compacting it by hand, and placing it on a slab of slate on the floor. It is then pounded with a rounded river pebble until a flat pad is formed. This is doubled over and the material pounded again; this pounding and folding is repeated until the material is homogeneous. The body is then ready for use.

Forming and Finishing Techniques

Mehrab Shah said that his forming techniques are similar for all the different types of pottery he makes, since in each case the basic shape is similar. He demonstrated the making of a vessel to be used for the storage of kneaded dough for making bread (Plates 8, 9).

The body is used at the stiff plastic stage, firmer than would be used for throwing on the potter's wheel. Even so the body still has a very plastic feel. The first stage in forming the pot is to roll out a coil of clay about 3.5 cm in diameter. This coil is then slightly flattened and joined to a willow hoop of suitable diameter by pressing the clay into the gaps between the twisted willow twigs and smearing it in firmly. With the hoop acting as a firm support, the potter then begins to raise the walls of the vessel by pinching, squeezing the clay between fingers and thumbs. When the wall is raised to a height of about 6 to 7 cm, he begins the process of beating, using the wooden paddle in his right hand and a stone anvil in his left (Plate 8*c,d*). This is continued, working gradually around the pot, until the walls are thinned to about 0.5 cm and are a height of about 15 cm. Another coil is then formed and added to the outer top rim of the vessel. No drying is allowed before this coil is added; the walls of the vessel are still soft. The rim of the vessel is smeared over the inside of the coil to effect a joint between the two.

The potter then sits with the willow hoop resting on his knees. Holding the stone anvil in his left hand, he continues the beating from underneath the vessel, using the paddle in his right hand. From this stage onward the beating is directed toward closing over the walls of the pot to form a hemispherically closed vessel, which afterwards becomes the base of the round-bottomed vessel. As the coil is beaten and thinned the walls gradually work over to form a rounded shape (Plate 9*a,b*).

When complete, this vessel of semiplastic clay, with a hoop attached at the rim, is left to dry just enough so that the hoop can be removed without damage. After a short drying period of about five minutes in the sun, during which the vessel rests on the hoop, a damp cloth is placed around the rim of the vessel so that only the rounded bottom can dry further to a firm leather-hard state.

The potter then removes the hoop by holding the pot between his left forearm and his chest, and lifting off the hoop carefully, insures that no cracks form in the wall of the vessel. Prior to this point, the vessel is formed upside down; from this point onward forming is completed with the vessel right side up. A cloth-wound cane hoop is placed on the ground as a support for the vessel. First, using the paddle and anvil, the potter smooths the rim, which is left rough by removal of the cane hoop. The rim is then leveled by beating gently with the beater. The final stage of forming for this particular vessel was to flare out the rim slightly with a pinching technique, using the thumb of the right hand inside the vessel and the fingers outside the rim, at a level below the thumb. After the rim is given a final smoothing, using only wet fingers, the vessel is complete and ready for final drying before firing.

The potter uses virtually identical techniques for other vessels, except that the shapes are modified for different usage. For example, the large water pot (diameter about 45 cm) is closed in at the top, with a more pronounced neck, which necessitates the addition of an extra coil of clay at the top. Basically, though, the forming techniques are similar. It must be noted that the completed vessels show no evidence that the hoop was used in the early stages of forming, at least on visual examination of the vessels. Both the interior and exterior of the vessel show evidence only of the coiling technique.

The body used by Mehrab Shah is very plastic and has a high drying shrinkage. Consequently, it is common for small drying cracks to form during one of the drying stages. These cracks, according to Mehrab Shah, usually form at the base of the pots. He repairs them before firing by wetting the interior of the pot with a wet rag (when the pot is almost bone dry), then sprinkling dry powdered clay inside the pot. Using a very wet rag, he rubs the inside of the pot vigorously to form a slurry from the dry clay. This slurry is then forced through the crack from the inside until it appears on the outside of the vessel. The vessel is then dried normally in the sun. If the crack has not completely repaired, the process is then repeated.

According to Mehrab Shah, the tools and techniques of the Madak potters are similar to his with only one major exception. Instead of using a hoop to support the pot in the initial forming stages, the Madak potters use the base of a broken pot as a mold. A flat pad of clay is formed into this mold, and the sides are coiled up from this, using similar coiling and beating techniques to those of Mehrab Shah. The vessels that have the base formed in a mold show very distinct mold marks (Plate 11*b*) on the exterior lower wall. The vessels made using the hoop techniques have no corresponding markings, so it is a simple matter to differentiate pots made by these two basically similar techniques. Mehrab Shah said that the other processes, such as body making and firing,

are identical to his, although sometimes when wood is not available for firing, dry grass or bushes are substituted for wood by the Madak potters.

The range of vessels made by Mehrab Shah is limited to only three basically different shapes. One of these, the basic water pot is made in three sizes for different purposes. The largest, about 45 cm maximum diameter, is for water storage. The intermediate size, about 38–40 cm diameter, is for storage of milk or curd. The smallest, about 22 cm maximum diameter, is for the storage of dough ready for use. Other pots are pitchers for milk (Plate 11*b*) (which have a spout formed from a flattened piece of clay bent to shape and joined to the wall of the pot, with a hole cut in the wall) and cooking pots, in various sizes, the diameter at the top ranging from 15 to 35 cm.

The Madak potters make the same range of pots as Mehrab Shah, but make two other types of pot as well: an eating bowl, the mouth diameter varying from 15 to 35 cm, and a large pot for grain storage, up to 85 cm in height.

Firing

All vessels are allowed to dry completely before firing. There is no preheating. The area for the bonfiring is some 300 m from the potter's house, on land which is common village property. The special area set aside for firing has a depression some 2 m in diameter and 0.3 m deep, excavated from slightly sloping ground (Plate 10*b*). This is large enough for his normal firings of some 40–50 pots. The observed firing fulfilled a small order of only seven pots, four of these were large water pots, but the potter said the firing procedures used are identical to those for large firings.

The vessels are carried from the workplace to the firing area by a boy acting as the potter's assistant. The potter cleans off the firing area by removing some of the larger pieces of stone that accumulated since the previous firing. While he does this, a wood supplier brings a one maund (about 40 kg) load of wood, sufficient for a small firing. A full firing of 40 pots requires four maunds of wood. The fuel wood is pine. For setting, the potter first lays a horizontal row of pieces of wood, each piece about 1 m in length and about 5–10 cm in diameter. All the wood is split longitudinally. The vessels are then set on top of this initial layer of wood, each resting on its side, mouth angled slightly downwards. More pieces of wood are then laid horizontally across the top of the vessels. This is continued until the pots are completely covered with wood.

The potter then lights the fire by igniting a bundle of bush, pushing this into the interior of the setting at one point, and continuing this around the setting until the fire is burning evenly at a number of points. (The bush is an herb, a species of *Artemesia,* which grows wild in the area, and is generally used as a fuel for cooking fires when wood is not available.)

The fire burns first at the top of the setting and only after 15 minutes does the wood underneath the vessels begin to burn freely. By this time the wood that is burning on top of the pots begins to be depleted. This means that the initial burning is mostly above the vessels, which tends to dissipate most of the heat upwards, thereby acting as a crude form of preheating before the wood underneath begins to burn and expose the pots to the full heat of the fire. After the fuel is burning, no further fuel is added and no adjustment is made to the fire at any stage. The total burning takes about 30 minutes before all the flames cease, and the charcoal and ash is still glowing strongly after one hour.

After four hours the vessels are cool enough to handle. By this time almost all the charcoal is burned, and there is only a residue of ash. Some of the vessels are damaged in the firing; all have a fine network of fire-cracks on the surface, indicating that the rate of heating is too rapid when the clay minerals are losing water of crystallization. On some of the vessels (Plate 10*h*) large areas of the surface are spalled off. Examination of these fractures shows that they are related to the distribution of slate fragments in the pottery body. The slate fragments become aligned in the center wall of the pots by the beating process during forming, and the pieces which are spalled off in the firing are parted along the line of foliation of the slate fragments.

DIR, NORTHWEST FRONTIER PROVINCE

The town of Dir is some 130 km by air north of Peshawar, 240 km by road. After the road from Peshawar crosses the Malakand Pass at Chakdara Fort the road branches, the left branch going to Dir (and Chitral, via the Lawarai Pass), and the right branch going to Swaṭ (and Gilgit, via the Upper Indus road). The road to Dir is open most of the year, although it may be closed for short periods by heavy snow in

the winter. The road can be traveled by trucks and cars, so Dir is relatively easily accessible.

Dir is at an altitude of 1700 m, with the main portion of the town on the right bank of the Panjkora River. Most dwellings are built from wood and locally obtained stone, mud plastered; the flat roofs are of timber and twigs, also mud plastered. Grain crops are grown in terraced fields; the production is insufficient to meet local needs so that some grain is imported.

Khan Zada is one of the four potters (*kulāl*) working in and near Dir. Because the prices of pots are competitive with those of wares such as aluminum, the demands of the market are sufficient to support this number of potters. All potters work in the summer season only; during the winter snow makes access to clay deposits difficult, and firing almost impossible.

Khan Zada is more than 70 years old and almost blind. He said that when he was younger he had been a farmer as well as a potter, but because of his failing sight he has been forced to stop farming activities. These have been taken over by younger members of his family. Also because of his partial blindness he has cut down his production of pottery.

Despite this, some of his customers said that his pottery is the best available in Dir. His output maximum is 300 pots per month, as compared to 600 when he was younger. The pottery is distributed in Dir and nearby villages, a large portion of it going to Kohistan, the mountain tract near Dir, between the Dir and Swat valleys. Some pots are made on order, but the market is reliable enough that he can make pots of standard types and rely on their being sold at a later date. At the time of the interviews he had no reserve stocks of pots at his workshop, all his previous production having been sold. Within Dir, some of his pots are sold to customers who buy from him directly, and the rest is sold to shopkeepers in the bazaar.

Khan Zada is unusual among NWFP potters in that pottery is not a hereditary craft in his family. He was born in Barwa, about 70 km from Dir, where he became apprenticed to a potter, Mahommed Ullah, when he was 15 years old. After the training period he moved to Dir and established his workshop there. Since then he has worked as both potter and farmer, the farming producing enough food for the immediate needs of his family. The types of pottery made by Khan Zada are still the same as those made by his original teacher. The other potters of Dir, all potters by heredity, all make similar types of pots.

There are no special assistants employed at the potter's workshop, but members of his family, particularly his daughters, assist with various tasks. Their assistance has become more vital since Khan Zada's sight has deteriorated; they have taken over jobs that he had formerly done himself, including the digging of clay and sand and their transport to the workshop.

Other tasks, also normally done by the women of the household include carrying pots around at various stages of the making process (moving freshly made pots away from the wheel, carrying pots into the sun for drying and bringing them back inside when dry), and assistance with setting the kiln. In the latter task all the kiln fuel is prepared by the women and brought to the kiln, and all the pots are carried to the kiln by the women. So basically the women of the household assist with all the unskilled tasks of the pottery-making process.

Khan Zada's workshop and kiln are combined with his house (Figure 2). The entrance to his property opens into a small yard, on one side of which is the kiln and stacks of dung fuel for firing. On the other side of this area is a room for male guests. A gate from the first yard opens into the main living and working area. The living area was not seen, since strict *purdah* was observed in the household. (*Purdah* is the custom of requiring women to wear a veil or garment to hide the face and exclude men from various sections of the house.) The main workshop area is near the entrance doorway to the living quarters. Under a twig-and-mud roof is the potter's wheel (*dukān*); within arm's reach of the wheel are molds for throwing, all the tools used in throwing, a low table for clay preparation, and a water bowl and cloth. Next to this work area is a slightly raised earthen floor, also under cover, which is used by the women of the house for preparing meals but can also be used for drying pots in the shade.

Opposite the covered working area is a relatively large yard; in one corner of which is a further supply of dung fuel, next to a small wooden hut where agricultural implements are stored, and an area where water pots for drinking water are placed. A pit for clay storage is located near the small storage hut. The main yard is uncluttered, leaving areas for placing pots in the sun for drying. Some chickens kept by the household roam freely in this area, often moving close to the working potter who completely ignores them.

Tools and Equipment

Potter's Wheel (*dukān*).—Since this wheel is typical of the type that is common among potters of the NWFP and the Panjab, it is described in detail. The general construction of the wheel is seen in Figure 3.

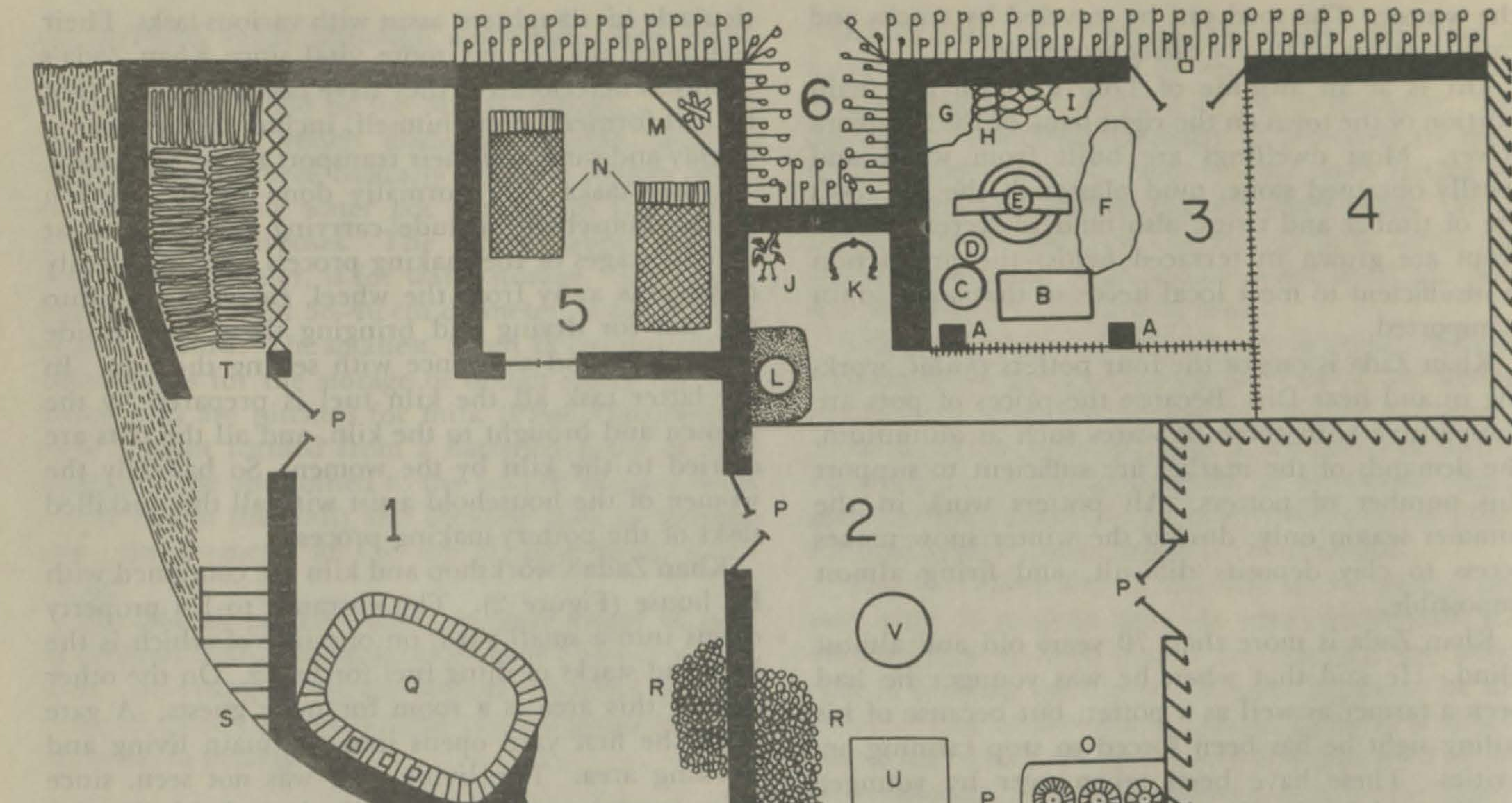


FIGURE 2.—Plan of workshop and dwelling of potter Khan Zada of Dir, NWFP 1, entrance courtyard; 2, inner courtyard, unroofed; 3, potter's roofed working area (the floor level is 20 cm above level of courtyard; step indicated by hatched line); 4, roofed area, used for drying vessels in shade; 5, visitor's room for male guests; 6, dwelling area, restricted access to male visitors, detailed plan not available. (A=pillars supporting roof of workshop, B=clay preparation bench, C=storage area for tools, D=water container, E=potter's wheel, F=storage area for clay from deposits, before preparation, G=storage area for coarse sand, H=storage area for base molds used in throwing, I=storage area for fine sieved sand, J=area where chickens sleep, K=cooking area, L=*tanur* (bread oven), M=fireplace in guest's room, N=beds in guest's room, O=water pots for domestic water storage, P=gateway, Q=kiln, R=stacks of dung fuel for kiln, S=steps leading up from public roadway, T=wood fuel for domestic fires, U=small storage shed, V=body storage pit for plastic clay, W=earth bank along public roadway.)

The wooden structure is placed in a pit excavated in the ground; this pit is normally 80–90 cm deep and 80–90 cm in diameter. Laid across the top of the pit is a wooden plank, the crossmember, which acts as both a seat for the potter and as the top bearing for the wooden shaft, which passes through a hole in the center of the crossmember. The shaft is tapered, thinner at the top and thicker at the bottom. A circular flywheel is fitted over the lower part of the shaft. The flywheel is locked to the shaft either by having a central square tapered hole, which fits a corresponding square shank on the shaft, or else simply wedges to the taper on a circular shaft.

In the simplest form of wheel, an iron spike is driven into the bottom of the shaft; the point of this spike rests on a piece of soft stone, such as slate or a piece of very hard wood. This spike thus acts as the lower bearing for the wheel. Periodically the potter moves the piece of supporting stone or wood so that the spike is running near its point only, so that it does not wear too deep a hole in the supporting material. The point is lubricated; in remote areas such a lubricant as apricot kernels is used, but in areas where access is easier to modern lubricants, motor grease may be used. A wooden wheelhead fits on top of the shaft, keyed on by an appropriate

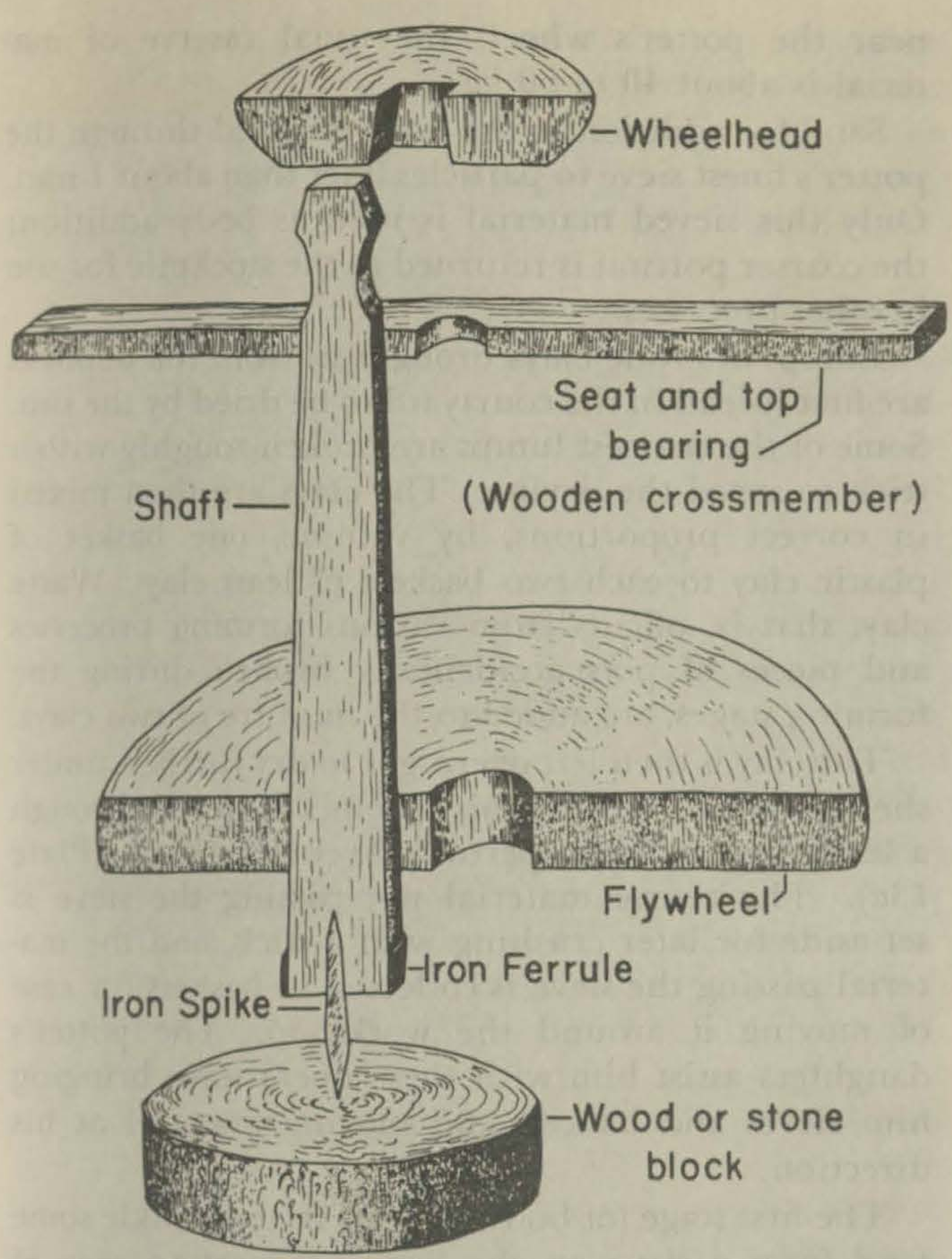


FIGURE 3.—Mechanical components of simplest type of Pakistani pit-wheel. Upper parts sectioned to illustrate how they fit together. The whole structure is placed in a pit, with a wood or stone block resting on bottom of pit, and wooden crossmember at ground level.

device such as a tapered square shank on top of the shaft.

The wheel (*sarkh dukān*) used by Khan Zada had the following components and dimensions: Diameter of pit: average 87 cm. Wooden crossmember: section 16 by 2.6 cm (pine wood). Flywheel (*pal*): made from one piece of pine, not built up by joining; diameter 66 cm; thickness 10 cm; tapered square hole in center. Shaft (*ghashay*): walnut; lathe turned to circular section; diameter 5 cm; tapered square shank at base to fit flywheel; tapered square shank at top to fit wheelhead (top shank cuts 5 cm into wheelhead). Bottom bearing: iron spike in shaft rested on an iron cup set in base of pit. Top bearing: the shaft located in a circular hole in wooden crossmember, lubricated with vegetable oil, packed with strips of cotton cloth. Wheelhead: diameter 35.5 cm; thickness 9 cm; rounded on bottom; flat across top; lathe-turned walnut. Distance, top wheelhead to top flywheel: 71 cm.

THROWING MOLDS (*qālib*).—Various diameters (Plate 14*a*); material biscuit-fired clay; round-bottomed dish-shape; potter keeps a stock of 25 of these.

CLOTH PAD (*cirṛa-cloth*).—Placed on wheelhead to support throwing molds; annular shape made from wound cotton (Plate 14*a*).

CLAY-PREPARATION BENCH.—Material pine wood, three planks on a base made from two pieces of pine (Plate 13*e-g*); maximum length 161 cm; maximum width 98 cm; overall height 13 cm.

WATER DISH AND CLOTH.—A cooking pot with broken rim, set into the ground near the potter's wheel and containing water used for wetting the pot while throwing; the cloth of waste cotton is used to apply water.

SIEVES.—Khan Zada had three sieves (*ghalbēl*), all of the same construction. A wooden frame, bent to circular shape, with untanned leather (*chamṛa*) stretches on one end of the frame and is tied with leather thong; sieve apertures formed by piercing holes in the leather. Two sieves are in the Smithsonian Department of Anthropology collection (Plate 12): the smaller, average diameter 28 cm, height 6 cm, oval-shaped apertures average 0.35 cm by 0.25 cm (USNM 417,609); the larger, elliptical shape, axes 35 cm, 32 cm; height 6.5 cm; apertures 1 by 0.5 cm (USNM 417,610). Similar sieves are used by others in Dir for sieving grain, with different size of aperture for different grain types.

PADDLES (*tapanā*).—Khan Zada had four wooden paddles of varying sizes for forming vessels of different curvatures (Plate 79*a*). Two are in the Smithsonian Institution collection. The largest has an overall length 36.5 cm; handle 20.5 cm long; diameter 3.4 cm; blade width 11.5 cm; blade thickness tapers from 3 cm at handle to 1.7 cm at tip; the smallest overall length 29.5 cm; handle 2.4 cm diameter; blade 6.5 cm wide; 8 cm long; thickness tapers from 1.5 cm to 0 cm at tip.

ANVILS (*ghundāray*).—Khan Zada had seven of these of various diameters and curvatures for different shapes of pots; material fired clay; one is in the Smithsonian Institution collection (USNM 417,381), height 5.5 cm; diameter 8.0 cm (Plate 30).

SMOOTHING TOOLS (*mangay*).—Wooden, for smoothing walls of pots during throwing. Two are in the Smithsonian Institution collection: one (USNM 417,383), overall length 23 cm; handle 2.5 cm diameter; blade 5.2 cm wide; 7 cm long; blade thickness tapers from 1 cm at handle to a sharp pointed tip (Plate 79*f*). The other (USNM 417,382), double-ended, overall length 21.5 cm; larger blade 5.5 by 5 cm; smaller blade 3 by 3 cm (Plate 79*e*).

KNIFE.—Large knife with steel blade, overall length 33 cm, used for cutting off excess clay at the

base of thrown pottery shapes before beating with paddle and anvil.

BASKET.—Used for carrying clay and for storing and carrying dung fuel for firing. Woven from willow twigs (vernacular *ghurājan*). Diameter about 50 cm but each is different size (Plate 17).

DIGGING TOOL.—For clay digging, also used for breaking up lumps of clay at the pottery and for breaking up dung fuel for firing (Plate 17*d*). Wooden handle, forged iron point.

MATERIALS GATHERING AND PREPARATION

The pottery body used by Khan Zada is a mixture of two clays (*khawra*). Neither deposit could be visited by Owen Rye because the only available guides to the deposits are the daughters of the household, and *purdah* restrictions prohibit them from being accompanied by a male who is not a member of the family. The daughters normally take two donkeys to carry the clay back to the pottery. Both deposits are about 2 km from the workshop, but in different directions.

Khan Zada considers one of the clays superior to the other. When questioned, he first said that his experience told him so. On the further questioning he pointed out that if the inferior clay is used alone, the pots do not stand on the wheel but collapse during the throwing. On the other hand, if the superior clay is used alone the pots will crack during the drying. So the two clays are mixed in proportions of two parts inferior clay to one part superior clay by volume to give a suitable body. His explanation is consistent with the "superior" clay being a highly plastic material, with high drying shrinkage and consequent liability to cracking; and the "inferior" clay being a short or lean material with insufficient plasticity for throwing, but with good drying properties. The second material contains a high proportion of nonplastic minerals, which accounts for its shortness.

Clay brought in from the deposits is not stored as such at the pottery. The normal practice is to collect clay only when a batch of body is to be made up, and to make the body and store the plastic material instead.

Sand also is used in body preparation, as well as in other stages of the forming processes. This sand, also collected by the daughters, is river sand from the Panjkora River, about 1.5 km from the potter's house. The daughters are instructed to bring only the finest grade of sand available. The same sand is used by builders in the district for making concrete, which is used in some government buildings. A store of sand is kept at the pottery workshop, in a corner near the potter's wheel; the usual reserve of material is about 40 to 50 kg.

Sand for addition to the body is sieved through the potter's finest sieve to particles finer than about 1 mm. Only this sieved material is used as body addition; the coarser portion is returned to the stockpile for use in other processes.

Lumps of crude clays brought in from the deposits are first spread in the courtyard to be dried by the sun. Some of the coarsest lumps are broken roughly with a stick to speed the drying. The clays are then mixed in correct proportions, by volume, one basket of plastic clay to each two baskets of lean clay. Waste clay, that is, offcuts from various forming processes and pieces of pots accidentally broken during the forming stages, are added to the mixture of two clays.

The clay is then left overnight to dry further, under shelter. Next morning this clay mix is sieved through a leather sieve with apertures averaging 1 cm (Plate 13*a*). The coarse material not passing the sieve is set aside for later crushing with a stick, and the material passing the sieve is collected in baskets for ease of moving it around the workshop. The potter's daughters assist him with these operations, bringing him sieves and baskets and moving material at his direction.

The first stage (of body mixing) in to sprinkle some sand from a sieve on the body preparation area of the workshop floor, near to the potter's wheel (Plate 13*b*). The sand is sufficient to completely cover the ground from view but the exact quantity eventually combining with the clay is difficult to assess. The sand is used for two reasons: to prevent wet clay from sticking to the earthen floor of the workshop, and to prevent contamination of the body by the mud of the floor. Sand eventually combined with the body is thus not specifically present as a nonplastic addition, but as a concomitant necessity of the limitations of the preparation process.

About 20 kg of sieved clay is then spread in a conical pile on top of the sand. The center of the pile is then hollowed by moving material from the center to the sides, and water poured into the center of the hollow pile (Plate 13*c*). The correct amount of water to add is judged by the potter as being just sufficient to make the clay plastic, with no excess water. Some clay is moved from the outside of the pile to the center into the water, to insure that the clay is wetted evenly. The clay is then left to soak overnight, so that it can be prepared for use the next day.

This means that on one day crude clay is left out to dry overnight; the next day sand and clay are sieved and the clay wetted; and on the third day the

clay is kneaded and ready for use. Normally, Khan Zada prepares larger amounts of body then he used for the demonstration of his techniques described here. The plastic body is stockpiled in an underground pit. When full, this pit holds enough body for one month's production.

After the clay body is left to soak overnight, it is prepared for use the next morning. The potter first gathers up the plastic clay, which overnight has become evenly and completely wetted (Plate 13*d*). The clay is piled on the low clay preparation table which is given a coating of fine sand to prevent the clay from sticking to it, near the potter's wheel. He kneads the material roughly by hand, making it up into one large lump, which he places in the center of the table. He then begins to knead the clay by foot. Using his right foot only, and standing with his left foot off the side of the table, he spreads the mass of material out flat, working evenly and regularly along the lump (Plate 13*f*). He then folds over clay at the sides of the flat mass, and working from one end rolls the whole mass into a cylinder (Plate 13*g*). This cylindrical lump is placed in the center of the table and the foot-kneading repeated in such a way that the mass of clay is turned through 90° from its original position. The foot-kneading, rolling up and turning the lump, is repeated a number of times to insure that the mass is homogeneously mixed. The total amount of sand added to the body during the preparation processes is estimated at about 10 percent by volume of the original amount of dry clay. He explained that during the foot-kneading, if the clay is a little dry, some water can be sprinkled on between kneadings until it is wet enough; alternatively, if the clay is a little too wet some dry powdered clay and sand can be sprinkled over the mass while it is spread out flat.

After the final treading out of the mass, the clay is not rolled up as before, but the mass is divided into lumps, each of about 7–8 kg of clay. These lumps are then individually hand-kneaded. The lump is rolled with both hands away from the body, to form a cylinder about three times longer than its diameter. This is then turned 90° and folded over double, turned again through 90° and the process repeated, another five or six times for each lump. When each lump is prepared, the potter sieves some coarse sand onto the table and rolls each lump in the sand so that is becomes coated. At the same time a little water is sprinkled on the outside of each lump to compensate for the drying effect of the sand. The body is then ready for use on the wheel. According to the potter, the effect of the final addition of coarse sand is to give additional strength and durability to the fired pots.

Forming and Finishing Techniques

All vessels made by Khan Zada, with the exception of the *tanur,* and cooking pot stands, receive preliminary forming on the potter's wheel. Flat ware such as lids and dishes receive their final shape on the wheel but hollowware pots require finishing to final shape with paddle and anvil.

The standard method of making various vessels was demonstrated by Khan Zada. The forming of a cooking pot illustrated the basic techniques. Clay body for use is placed near the potter's wheel, on the low table used for clay preparation. The potter first places a mold (*qālib*) on the wheel (Plate 14*a*). This rests on an annular cloth pad placed on the wooden wheelhead itself. Then, kicking the flywheel with his right foot (i.e., with the wheel revolving counterclockwise),, he centers (*sam*) the mold by tapping away from his body with the heel of his right hand. At all times when working at the wheel his left foot is placed on the wooden crossmember, close to his body, behind the wheelhead. This gives him a stable rest for his arms or hands while working, since he can brace solidly against his left leg. During the centering of the mold, his left hand, braced against his leg so it cannot move, brushes against the rim of the revolving mold to indicate how much it is out of center. This indicates how hard it is necessary to tap the mold to bring it into center. It should be noted that because the mold is round-bottomed, it has to be leveled as well as centered. The whole operation takes a few seconds only, but the potter displays a high level of skill and judgment.

The next stage is to form the base (*tālay*) of the vessel. From the nearby stock of kneaded clay he takes about 1.5 kg of body, by simply dragging material from the top of a lump with the tips of his fingers. This is compacted into a lump. Then he spreads a thin layer of sand onto the earthen floor beside the wheel. The lump of clay is placed on this sand and patted down flat with the flattened fingers and palms of both hands. The clay is revolved at the same time so that it flattens evenly; more pressure is applied to the center of the mass than at the rim so that the whole will be of even thickness. The end result is a flat piece of clay about 1.5 cm thick and 30 cm in diameter. This is then transferred to the mold on the wheelhead and placed carefully, so that the clay is centered.

Another lot of clay is then taken from the nearby stock, this time about 3 kg. After forming this into a lump the potter rolls it between his hands to form a coil (Plate 14*c*). Holding the partially formed coil vertically he rolls the clay between his hands, first

finished the vessels are put aside to dry overnight.

When the base is sufficiently dry the vessel is removed from the mold by simply lifting it out; the parting is facilitated by the coating of sand the base received in its initial forming as a circular disc. Rough edges left at the base of the vessel are smoothed by scraping with the blade of a knife before the beating process begins (Plate 16*a*). He sits with his back leaning against a wall, his legs straight, and with a cloth on his lap on which to rest the vessel being formed. When beginning to work with the paddle and anvil, the vessel is placed with its mouth to his left side, so that his left hand holding the anvil. can be inserted easily. His left forearm can then steady the vessel by resting against the mouth, as his hand moves the anvil around the inside the vessel independently. The paddle is used in his right hand (Plate 16*b*). The size of the paddle and curvature of its blade is chosen to suit the curvature of the vessel being formed. The center of the base is beaten first, the beating gradually is extended to the sides, in a continuous sequence moving around the vessel by turning it in his lap.

Occasionally during the beating of the base the clay cracks, leaving a large rent in the base. On one occasion this was so extensive that a complete section of the base fell out. According to the potter this only occurs when the clay is too stiff; but the clay cannot be resoftened a little by adding water, as the base then becomes unevenly soft and unworkable. The cracks are repaired by beating the cracked section so that one portion overlaps another (Plate 16*d*), and then blending this overlap by further beating to form a continuous wall section. This mending is done so skillfully that afterwards it is impossible to determine where the cracked section was. In an observed case where a section completely broke away, the potter stuck it back in place with some plastic body and continued beating until the fracture was repaired. When the beating is finished the vessels are placed upside down on the wheelhead and, with the wheel revolving at about 60 rpm, the bottoms are polished with a wooden smoothing tool. Once the polishing process is completed, the vessels are put aside to dry to a completely bone-dry condition.

The overall cycle of the work is on a three-day basis. On one afternoon the potter mixes clays, sieves the clays, and wets the body. The next morning the body is kneaded, and a batch of some 15 to 25 vessels, depending on their sizes, is thrown and dried to almost leather hard. The second afternoon the vessels are smoothed and the upper walls completed. After drying overnight, on the third morning the bottoms are finished to shape with the paddle and anvil. On the third afternoon the cycle begins again with the preparation of more body. These cycles are repeated until the potter accumulates enough vessels for a firing. All are then decorated at one sitting, and then fired.

Decoration

All vessels are decorated with a red slip applied when they have dried completely. The slip is made from a reddish clay, obtained locally, by soaking the clay in water and then mixing to an even consistency. The slip is applied to the vessels by women of the potter's household, not by the potter himself. The prepared slip, kept in an old cooking-pot, is stirred before use, and then wiped onto the vessels with a cloth. This method of application has the effect of slightly polishing the surface at the same time as the coating is applied. After the slip is applied, the vessels are dried in direct sunlight, and then wiped over with a dry cloth to remove any coarse particles of material from the surface. Unused slip is left in the vessel used as a slip container. It dries out in the intervals between use, but it is prepared again each time simply by adding more water and more red clay as the slip is used up.

The vessels are further decorated with a black pigment applied over the red slip. The basic material for this pigment is a black stone, imported from Bajuar, at a cost of two rupees per seer (the rate of usage being about one seer, approximately 1 kg, per annum). The stone is crushed coarsely by beating with a river pebble, and then ground to a fine powder on a stone mortar with a stone pestle. This fine powder is then placed in a bowl and sufficient water added to form a thin suspension. No other addition is made. The pigment is applied with an 8-cm long brush made from hairs of a donkey's mane and tied in a bundle with cotton thread. Vessels are placed on the wheel, and bands of decoration are applied with the hair brush as the wheel revolves at a moderate speed of about 40 rpm. Wavy bands are also applied with the vessel on the wheel. Diagonal stripes are applied to the flared rim of cooking pots after the vessels are removed from the wheel. Khan Zada pointed out that the decoration is not durable, even after firing, but that it is expected to be present when the buyers of his pottery come; the people will not buy them without the black decoration. Sometimes the brushwork is done by his daughter, who he said does work of the same standard as his own.

Firing

The kiln (*paja*) is basically an open pit, with no effective means of draft control (thus no control over

air to fuel ratio) and no provision for addition of fuel as the firing progresses. Usually in the Northwest Frontier Province similar kilns are built above ground level by constructing stone walls; but because of the unusual site of Khan Zada's workshop, his kiln is constructed basically by excavation. The site on which his house and workshop are constructed is level, but the surrounding land is sloping; thus, the back of his house and workshop are at ground level, but the front of his land is raised above ground level on a steep bank. The pit for his kiln was excavated by digging back into this bank, thus forming three sides of the kiln. The fourth side, or front of the kiln, was finished by building a stone wall across the front of the pit. This wall is built from rounded river pebbles, a normal house-building material in Dir, and plastered over with mud (again a normal house-building technique). The back and two side walls are faced with mud-plastered stone, as is the floor; the floor level is thus about 30 cm above the outer ground level. The kiln interior, or chamber, is roughly elliptical, the axes at floor level measure 135 cm and 185 cm, with the overall dimensions at the top 180 by 305 cm. The height of the front wall is 84 cm, and of the back and side walls 130 cm. Three air inlets are built into the front wall, each of these about 15 cm wide and 30 cm high, set half way up the wall. The top of these openings are bridged with slabs of slate (Plate 17*a*).

The fuel for firing is donkey dung mixed with straw. The potter said that this type of kiln can be fired with wood, but that wood has two strong disadvantages: The first is that many vessels are broken in the firing, because they are heated too quickly, or because the wood collapses as it burns away. The second is that the dung-straw fuel is more readily available than wood, and can be obtained by barter rather than cash exchange as is necessary for wood; if bought with cash, dung fuel is much cheaper than wood. The dung fuel (*sapyāka*) is purchased by the basketful from the people of villages surrounding Dir, each basket containing about 10 kg of fuel. Five baskets of fuel can be obtained in exchange for one large water pot, or for two to four smaller vessels, depending on the specific item and the difficulty of the bargaining. The general cost of dung fuel in the district on a cash basis is 6 paisa (see "Glossary") for 12 large dung cakes. The fuel is supplied to the potter in the form of prepared cakes about 25 cm in diameter and about 5 cm thick. Occasionally the potter barters vessels for the dung fuel. A supply of this fuel, sufficient for at least three or four firings, is kept stored in the potter's yard near the kiln. The setting of the kiln may be described briefly as the placing of alternating layers of fuel and vessels. First, a layer of dung cakes is set on the floor of the kiln; these cakes of fuel overlap one another slightly because they are stood on edge at an agle of about 45° to vertical. The density of setting of the fuel cakes is 5 or 6 cakes per 0.1 m^2 (Plate 17*b*). A layer of large vessels is then set on top of this, each one upside down (Plate 17*c*). As the layer of vessels extends across the kiln it is necessary for the potter to begin standing on the vessels themselves. He said that he very rarely breaks any vessels while walking across them, but admitted that it is a very skillful activity, and for this reason he does not trust anyone but himself to set the kiln, because an unskilled person would break the vessels.

While this first layer of vessels is being set in place, with the assistance of a boy who carries the vessels from their storage area to the potter, two women of the potter's household are preparing dung fuel for later stages of the setting (Plate 17*d*). They break the large dung cakes into pieces about 5–10 cm in diameter. When the first layer of vessels is set in position, the interstices between the pots are filled with smaller pieces of dung, and a layer of the finer pieces is spread to completely cover the vessels. The setting at this stage reaches to the level of the bottom of the airholes in the front wall of the kiln.

Another layer of vessels is then placed in position (Plate 17*f*). Lids are set in position on vessels requiring lids, although the vessels are still upside down. Flatware was not set for this firing, but the potter said that plates or dishes normally are placed in the top layer of pots, standing on edge. Normally, the largest vessels are set at the bottom and the smaller at the top. When all the vessels are set, the interstices are again filled with smaller pieces of dung fuel, until the pots are covered. Finally, a layer of unbroken dung cakes is set horizontally across the top of the entire setting, which is then complete.

Sixty-six vessels of various sizes, but mostly cooking pots, were set for this firing, and eighteen baskets of dung fuel were used (the equivalent in barter of five or six vessels from the firing).

A woman from the potter's family starts the firing by placing some small pieces of kindling (*litgē*) in each of the three air inlets in the front wall of the kiln. (The wood called *"sunti,"* is Blue Pine, *Pinus excelsa*, from the nearby mountains.) A few small pieces of the kindling are then lit and used to light the larger pieces and push the larger pieces in underneath the dung fuel in the kiln. The top level of the dung fuel in the kiln is above the top of the air inlets (Plate 17*f*). These wood fires are kept burning for

an hour, until the dung fuel begins to smolder, and afterward are left clear as air inlets.

While a woman begins the fire, Khan Zada obtains a small dishful of fine sand. He returns as the fire is beginning and, squatting on the front wall of the kiln, recites some verses from the Qur'an, and sprinkles the sand over the top of the setting (Plate 17*g*). He afterwards explained that the sand symbolically takes the power of the verse and transmits his prayer for the safety of the vessels to the vessels themselves. Further questioning revealed that this ritual is in accordance with the instructions contained in a book which he keeps in his house, which he calls the *"kulāl-nāma,"* or *"The Potter's Book"* (Appendix 5).

The kiln is set in one afternoon, the total time from the beginning of the setting to the commencement of the firing is three hours. Once the dung begins smoldering, the kiln is left and allowed to burn overnight. The next morning all the fuel is burned and the kiln is cool enough to remove the vessels (Plate 17*i*). The dung ash and vessels are settled considerably, occupying only half the volume before firing. Only two vessels were damaged in this firing, developing vertical cracks from the rim, the typical dunting cracks caused by cooling too quickly. Even so, they are still usable for storage, and can be sold or traded at reduced prices. Khan Zada said that provided there is no rain during a firing, his firing losses are usually low; but if there is rain, many vessels are lost. This is due to very rapid and uneven cooling. The practice of setting vessels upside down protects them from cracking due to dunting, as the rims of each vessel are protected from fast cooling by the insulating layer of ash surrounding them. The bases of the vessels accommodate the cooling stresses much better and, in use, cooking pots are subjected to such stresses as a normal condition. It was noted that cooking pots in use are periodically (once a week according to Khan Zada) coated on the base with a mixture of clay and sand to insulate the pot from thermal shock.

The ash left over from the dung fuel after firing is not thrown away, but is put aside by the potter for use as fertilizer on the fields where grain crops are grown. As he accumulates much more fertilizer than he himself can use on his land, the rest is given away to any villager who asks for it, but most often to villagers who purchase his pottery.

The potter judges the degree of firing, and hence the quality, of the pottery by the same method as that used by any pottery buyer in Pakistan. This is to tap the pottery and listen to the sound, either tapping with the knuckles, or with a stick. A flat, dull sound indicates that the vessel is underfired; a full, ringing sound that the vessel is well fired; and a reverberating sound that the vessel was cracked in the firing and is liable to early breakage in use. A common test of the degree of firing by potters in other parts of the world is to "taste" the vessel, that is, to place the tongue against it and gain an assessment of the apparent porosity according to the extent to which the tongue sticks to the vessel wall. Khan Zada had not heard of this, and has never used it; this is also true of other potters in Pakistan.

A few of the vessels from the firing described above had dark carbon stains in patches on the outer walls, but the majority had fired to an even reddish color. All had a light coating of ash, which could very easily be removed by brushing. The even red color indicates that there was sufficient air circulation through the fuel supply during firing to create relatively even oxidizing conditions. This was confirmed by the cross-section of a piece of pottery that was broken; there was only a faint gray core, indicating that oxidation had been sufficient to burn out the carbon from the interior of the walls of the pot.

Types of Pottery

The range of wares made by the potter include (Figure 4); large water storage vessels up to 60 cm diameter with a lid; water pitchers with handle and spout; water carrying pots (*mangay*); water drinking cups; and rice serving dishes. Flange-rimmed cooking pots, with rounded walls and base, are made in three sizes; the smallest called *"carakizay,"* the intermediate size, *"tirawizzay."* These vessels were for warming milk, for making tea, or for cooking rice, vegetable, or meat. Flanged-rimmed pots, with shoulder and round base (*degchay*), are used for cooking. The shape is different because some people preferred it esthetically, not for any functional reason. Storage pots (*qulpi*), with an inflanged rim, are used for preparing and storing flour/water mixtures for *capātī* (bread). Bread ovens (*tānūr*) could also be made by the potter, but these were made only on order. The larger vessels mentioned are only made on special order, but the smaller vessels are made and sold on the open market.

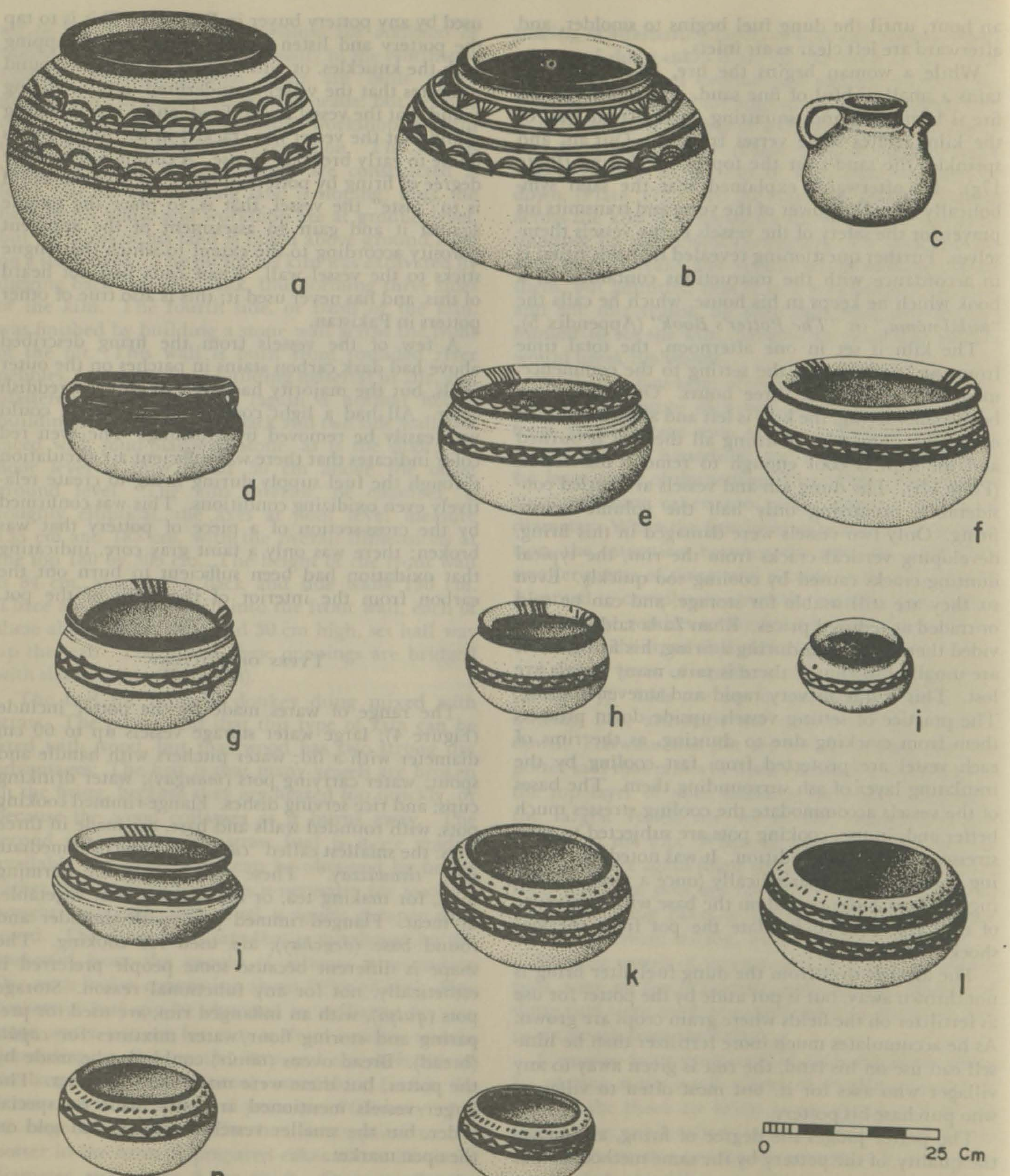


FIGURE 4.—Vessel types made by potter Khan Zada of Dir, NWFP: *a, b,* water pots; *c,* water pitcher; *d–f,* cooking pots; *g–i,* cooking pots (*carākizay*); *j,* cooking pots (*degcay*), *k–n,* storage pots (*qulpī*).

SWAT, NORTHWEST FRONTIER PROVINCE

Swat lies on the northeast of Peshawar. The major and adjoining towns of Mingora and Saidu Sharif are about 115 km in a straight line from Peshawar, and 200 km by road. Access to the Swat valley from the south is via the Malakand Pass; the road is asphalt and/or aggregate, so access is relatively easy and the Swat valley is becoming an increasingly popular area for tourists. The former Swat state was ceded to the Pakistan government on 30 July 1969 by the Wali of Swat.

The valley of Swat is located more or less parallel to the main valley of Dir, the two being divided by the hilly Kohistan area. The seasons of both Swat and Dir are similar; snowfall can be expected in the winter, and so potters in Swat, especially in areas of higher altitude, work only in the summer months. Most of the small villages in Swat have at least one potter, who supplies the needs of that village and some of the outlying areas around the village. There is no movement of pottery vessels away from the villages as exports, so that all production of traditional pottery is very localized. Despite this, there is an overall similarity of style among the Swati potters, so that only with a few exceptions is the pottery of one village distinct from that of another. One potter, Mahommed Sadek of Chamtalay village, in the upper Swat valley on the Shangla Road, which leads to the upper Indus valley, is producing ware decorated with a distinctive combination of colored slip patterns, not seen anywhere else in the Swat valley. Another, Mahommed Zarin, is making pottery oil lamps and pottery stands for wood fuel lamps, of a type not seen in other villages. Apart from these two potters, all others included in the study are making a similar range of wares.

Because of the increasing flow of tourists through Swat, a market for used pottery has been created. This is centered in Khwaza Khela, the bazaar town that has acted as an interchange point between the lower Swat valley and Kohistan. Used pots, as well as other household items, textiles, wood, metal, and leather, are now brought into Khwaza Khela from Kohistan, and are distributed to foreign tourists. This market in used pottery is a point of sale only for Kohistan villagers; they do not buy there. None of the styles of pottery seen at this distribution point were different to any seen in the villages, so it seems that the new trade has not stimulated any changes in style of pottery.

One potter interviewed in detail was Amir of Alam Ganj village, about 33 km upriver from Mingora. He is the only potter in this small village. Although he only makes pottery for the three months of summer (April–June) in each year, he has no other occupation and hence no other source of income. He comes from a traditional family of potters (*kulāl*), his father and grandfather having been potters in the same village. As with other Swati village potters, his workshop is combined with his house. The potter's wheel and tools are under a covered area at the side of the mud-and-straw plastered stone house; this covered area fronts onto an open courtyard, where pottery vessels can be left after drying and where the body is made up, and the raw materials stored. Most of his work is done under the covered area, which provides shade from the sun. He works without paid assistants, but the women of his household help with the unskilled work, such as moving the vessels from one area to another, and with the more skilled task of applying red slip to the dried vessels.

Almost all the pottery made by Amir is sold in the village of Alam Ganj, or in nearby areas. Some is made on order but the majority is made and sold by the potter on the basis of his previous experience of demand for the various types of ware.

Tools and Equipment

The variety of tools used by the potter is similar to that used by Khan Zada of Dir. In general, the methods of making and firing the pottery are very similar to those seen in Dir. The pottery is also similar in function, although the styles of the vessels are quite distinct from those of Dir.

The potter's wheel (*dukān*) used by Amir is of the general pit type; the top bearing being simply the lubricated shaft turning in the wooden top crossmember, and the bottom bearing being a steel point (*sumbā*) driven into the base of the shaft and revolving in a cup of stone (*bakria*) that is set into a piece of wood permanently placed in the bottom of the pit. The wooden top crossmember is of pine; the wheelhead, 35.4 cm in diameter, is of turned deodar wood. The flywheel (*pal*) is also turned deodar, measuring 8 cm thick and 71 cm in diameter. The shaft (*ghashay*) is turned walnut; the wheelhead is fixed to the top of the shaft on a square boss and packed with a piece of cloth to keep the wheelhead firmly in position. The ground level around the pit is about 20 cm above the level of the crossmember, and thus a recess has been dug at the seating position to allow the potter to sit at the level of the crossmember.

Materials Gathering and Preparation

Amir obtains his own clay from a deposit on the left bank of the Swat River, 2 km from his workshop. The deposit has an overburden of about 60 cm of sand, and below this the next 50 cm of sandy clay is rejected, the usable clay being obtained from below that level. The potter digs clay only twice a year. Each time he digs about 50–60 maunds of clay, making a total clay consumption per year of 100–120 maunds of clay, approximately 4500 kg. The clay is transported to the pottery on mules. Amir also obtains sand from deposits near the river; this sand is dried and then sieved to give two grades.

Amir's normal practice is to make up large batches of body, and then store the plastic material is an underground storage pit. This pit is 2 m deep and 1.1 m in diameter at the base, tapering to 0.5 m diameter at the ground level opening. If full, the potter said, it can store enough clay for the full three month's work.

He demonstrated his method of making body by making a batch of about one maund. The clay, after being dried in the sun for 2–3 days, is beaten with a stick to break up the larger lumps. Some coarse sand is then sprinkled on the ground over an area about 1 m diameter in a section of the potter's courtyard that is set aside for clay preparation. The clay is spread out on top of this sand; 5 kg of fine sand is mixed with the clay. Water is added to the annular pile of clay, which is left to soak overnight; according to the potter, he sometimes lets it soak for two nights. It is then kneaded, first by foot-kneading in the same manner as used in Dir. Before kneading more sand is added to the body, in the same proportions as the initial sand addition, making a total addition of approximately one part of sand to four parts of clay, by volume. The second addition of sand varies according to the types of pottery to be made from the body. For cooking pots coarse sand is added; the potter explained that the vessels are then more resistant to breaking when placed on the cooking fire, that is, the coarse sand gives better thermal shock resistance. For pottery destined to contain liquids, such as water or milk, the potter adds fine sand; he explained that if coarse sand is added for this type of vessel the resulting pot will leak. This indicates that the body to which coarse sand is added is more permeable than that to which fine sand is added. At the stage of beating the round base, the potter sprinkles the base of cooking pots with coarse sand and the base of liquid-containing vessels with fine sand before the beating is begun. The exterior of the base of all finished vessels, therefore, has a higher sand content than the walls.

Forming and Finishing Techniques

The methods for forming pottery are similar to those of Khan Zada of Dir, that is the throwing of the initial shape of the vessel in a mold placed on the wheelhead, drying to leather hard, and then finishing the base of the vessels by beating with the paddle and anvil technique.

Amir's method of kneading clay by hand before throwing is distinctive. The amount of clay prepared varies with the size of vessel to be formed, between 1.5 and 3 kg at a time for the base of the vessels. The potter gathers the required amount of clay and rolls it into a cylinder in his hands. This cylinder is then held upright in the right hand, with the index finger and thumb resting halfway up the cylinder. The top part is then grasped with the left hand and folded back over the right hand. The portion held by the right hand is then torn away from that held by the left, and then beaten down onto the portion held in the left hand. The kneading process is then continued for 8 to 10 cycles.

Techniques for the initial forming of vessels on the wheel are also similar to those used in Dir. The potter uses biscuit-fired clay, dish-shaped molds, for forming the base of vessels. The mold is placed on an annular pad of cloth on the wheelhead. The base or large vessels is first formed as a flat disc of clay by patting out a ball of clay placed on sand sprinkled on the ground near the potter's wheel (Plate 18*a*). The walls of the vessel are thrown from coils added at the circumference of the base (Plate 18*b,c,d*). When throwing is completed the mold is removed from the wheelhead and the vessel allowed to dry to leather-hard condition before completing the shape by beating with the paddle and anvil.

When the vessels are dried to leather hard they are returned to the wheel for final smoothing on the upper walls, with a wooden smoothing tool. On some of the vessels a decorative band is applied at this stage. A fine coil of clay is formed, and fixed around the wall of the vessel with the wheel revolving slowly. It is then smoothed and firmly bonded to the vessel wall with the wheel revolving faster. Scalloped decoration is often applied on the decorative band by pressing one finger into the soft clay, forming indentation from 1–2 cm apart. Vessels to be used as containers, as opposed to flat ware dishes, etc., are all completed by beating out the round base with a paddle and anvil. The tools are almost identical to

those described from Dir (p. 19). After the paddling is completed the vessels are left to dry completely.

Decoration

Red slip is applied to all vessels after drying. This task is set aside for women of the potter's family. The slip (*sur rang*, literally translated as "red color") is made from a clay obtained in the nearby mountains by the potter. The clay is slaked in a container of water, stirred, and then set aside for sediment to settle. The finer, top portion is then poured off into another container. This fine portion is then used as the slip. It is diluted with water to a thin, watery consistency and applied to the vessels by wiping it on with a cloth, which is continually dipped in the slip to keep the cloth saturated.

Further decoration is applied to most vessels in the form of painting with a black pigment. Either the potter, or his children, paint decorations with a brush made from donkey mane. This black pigment (*tor rang*, literally translated as "black color") is applied in repetitive, segmented bands around the vessels.

Firing

The ware is fired in an open kiln (*pajā*) with dung fuel; all potters visited in Swat by Rye are using this type of kiln. It consists of a square structure with three stone and mud walls, 1.5 m high, and a lower front wall 0.8 m high. The front wall also is built from stone, but does not have the mud-mortar bonding of the back and side walls, thus allowing air to enter the setting from the front. The interior of the kiln is 3 m square on plan, the stone walls being about 0.4 m thick (Plate 19*c,d*). The kiln is at the back of the potter's house, about 50 m from the workshop area. Members of his family assist him with carrying the vessels to the kiln when it is to be set and fired.

Mahommed Zarin of Samak uses a similar kiln type (*pajā*). The dimensions, however, are different than for the kiln of Amir in Alam Ganj; the Samak kiln is a little smaller. The two sides walls, each 2.5 m long, and the back wall, 3.2 m long, are both 1.6 m in height. The front wall is 1 m high. This kiln is built on flat ground. It is fired once a month in a working season of four months per year. Each firing contains 300–500 vessels, representing a day's consumption of 10–12 maunds of dung fuel, or an average of about 2000 cākes of dung, each about 4 cm thick and 15 cm diameter. Four maunds of straw are used in each firing. The cost of fuel per firing is 15 rupees for dung and 20 rupees for straw. Sometimes the potter mixes some wood with the dung in the setting if he does not have enough dung, and wood can be obtained easily.

The potter sets the kiln by, first, filling the lower 0.5 m with dung cakes (*sapyāka*). The vessels are then set upside down above the dung layer, larger vessels at the bottom and smaller ones and lids at the top. The interstices between vessels are filled with small dung pieces. The top of the setting is then covered with straw, up to the level of the side and top walls. The straw is slightly moistened, not wet, and is packed down firmly. The layer after packing down is about 0.3 meters thick. The potter pointed out that if this straw burns through during the firing and a hole appears at the top, the hole is filled again by packing in more straw, at least in the early stages of firing. The straw is allowed to burn out toward the end of the firing. The kiln is normally set and fired in one day. The fire is started around midday by inserting some small pieces of burning wood into two holes, each about 12 by 20 cm, of irregular shape, at the base of the front wall. The kiln is cool enough to remove the vessels 24 hours after beginning the fire.

The firing of a similar kiln was described in an interview with Mahommed Sadek, a potter of Chamtalay village in upper Swat on the Shangla Road. He also works for 3–4 months per year depending on the season. His kiln (Plate 19*b*) is fired only twice a year, with 200–300 vessels in each firing. His technique differs from the other potters in that he uses a mixture of wood and dung fuel; in his village wood is more readily available, and he can cut his own wood fuel in the nearby mountains. But dung fuel is not plentiful, because the area is less densely settled than the lower Swat valley and there are less animals available to produce it. In one firing he uses 20 maunds of wood and 11 maunds of dung fuel.

Comparison of Swati Techniques

The working methods of all Swat potters interviewed are basically similar to those of Amir of Alam Ganj, with only a few distinctive variations. Mahommed Sadek of Chamtalay is producing a type of ware with distinctive decoration, which he said was characteristic of his village. He is the only potter in the village. His vessels are all decorated with a thin red slip, made from a red clay obtained near the village. Women of his family apply it to bone dry vessels with a cloth (Plate 19*a*). He also uses two pigments, one black and the other white. The white pigment is China clay from the Swat deposits. Both pigments

are prepared by grinding them to a fine powder, using a stone mortar and pestle. They are applied with brushes made from donkey mane. Only the potter himself does the painting. The final colors are a red slip with black, white, or dark green over the red slip. The dar kgreen is produced by painting white over black.

Mahommed Zarin of Samak is also the only potter in his village, the nearest pottery being in the next village about 5 km away. The craft is traditional in his family; he learned pottery making from his father and produces the same range of wares as did his father. He also works part-time as a farmer, growing grain on a small area of land. His production of about 2000 pottery vessels a season includes 50–100 oil or wood lamps, of a type used only by the poorest villagers. His vessels are usually decorated with red slip with the exception of the lamps, which are coated with a white slip made from China clay. The red-slipped vessels are decorated with painting in black. The black pigment is obtained by grinding a black stone obtained in the mountains at Babu, 10 km from Samak.

Abul-Waris of Deolai village was interviewed also. His techniques of pottery making and the range of pottery are similar to those already outlined.

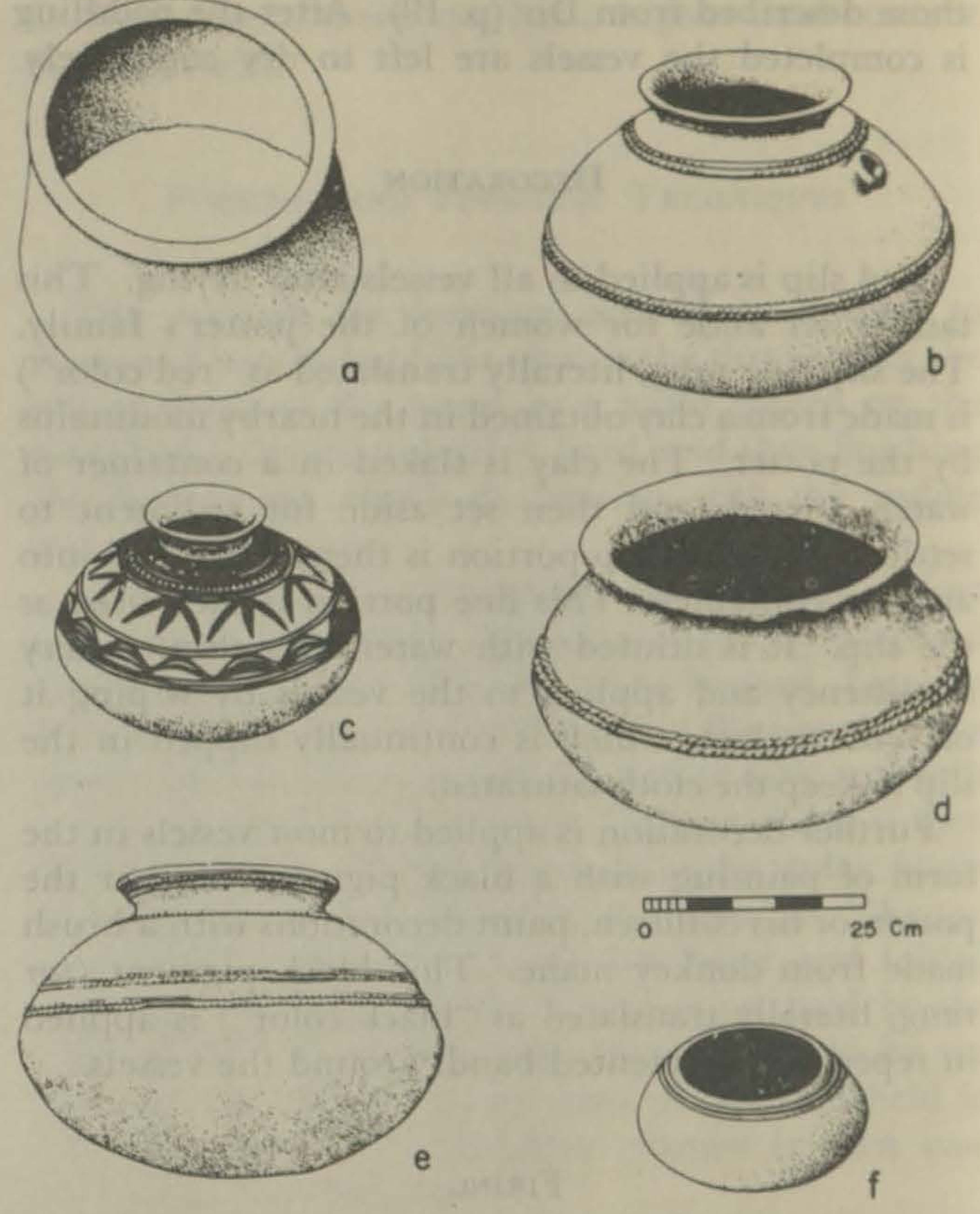


FIGURE 5.—Vessel types made by potter Amir of Alam Ganj, Swat: *a*, beehive; *b*, water storage pot with spout; *c*, water carrying pot (*mangay*); *d*, large cooking pot for rice; *e*, butter churn; *f*, storage pot (*qulpi*) (cf. Figure 4).

TYPES OF POTTERY

The range of pottery made by the potters of Swat is similar to the range seen in Dir, although the shapes and styles of decoration are quite distinctive. The Swati pottery is sensitively shaped and has a much finer overall appearance than that of Dir. The standard of craftsmanship is higher in Swat than in any other area where unglazed ware is produced. This is also in keeping with a general level of craftsmanship in Swat where fine woodcarving and embroidery are also common.

The range of pottery commonly produced includes: beehives (Figure 5*a*); large water storage pots, the largest about 45 cm diameter and 38 cm tall, with a pouring spout (Figure 5*b*); water carrying and storage pots (*mangay*), about 34 cm diameter and 28 cm height (Figure 5*c*); rice cooking pots, in various sizes, up to a maximum of 50 cm diameter (Figure 5*d*); butter churns, between 45 and 65 cm diameter and about 50 cm in height (Figure 5*e*), used in conjunction with a wooden churning device (*car;* Plate 20*d,e*); pots for making tea, 25 cm diameter at the mouth; pots (*qulfi*) for mixing and storing dough for bread, about 26 cm diameter (Figure 5*f*); flat dishes for cooking bread, about 35 cm diameter, usually decorated with a circular combed pattern in the center (Plate 20*a*); and dishes for preparing dough.

MUSAZI, NORTHWEST FRONTIER PROVINCE

The village of Musazi is 11 km south-southeast of Peshawar, and is one of a group of pottery villages in this region; others are Zakhel Bala and Pabbi. The latter village is on the Grand Trunk Road, the main route between Peshawar and Lahore, and about halfway between Peshawar and Nowshera. The town of Nowshera is the main junction between the Grand Trunk Road and roads leading to the north. When

traveling in an easterly direction from Peshawar along the Grand Trunk Road, one passes through Pabbi and Nowshera, and, further on, to Islamabad and Rawalpindi.

This places Pabbi in easy access to a number of important trade routes, and trucks traveling these routes provide an easy means of distribution for pottery. The potters in this region thus sell much of their wares to traders in Pabbi; these traders in turn sell to a wide area from the mountains to the north, to as far east as Rawalpindi. Pottery destined for villages in the north is trucked from either Pabbi or from Peshawar to a distribution center near Dargai, at the foot of the Malakand Pass, from where it is distributed to areas to the north and west of the Malakand.

Another reason for the wide distribution is that the potters produce a specialized range of wares, including Peshawar glazed ware, special types of very large water pots for bulk storage, and smaller water pots for storing drinking water. The latter two types are unglazed.

The glazed ware production is discussed elsewhere (pp. 77–86). The main production of large unglazed water vessels, according to traders in Pabbi, comes from the village Musazi; some potters in Pabbi are also producing these vessels. There are 16 workshops in the village, all producing the same limited range of pottery. Only an extremely small portion of the output is sold in the village itself. Most of it is destined for the trade regions mentioned previously. Inquiries in Musazi village revealed that the potters consider Abdul Janab the most skilled potter in Musazi and that the best pottery comes from his workshop; so the study centered there.

Two brothers, Abdul Janab and Mahommed Said, share the workshop under study. Abdul Janab said that they are descended from a traditional family of potters, where at least the eldest son is expected to become a potter. His father and grandfather had produced wares identical to those being made in 1971. The range of pottery is limited to three types: large water storage pots (*cātay*), of three sizes, for storing large amounts of water; small spherical water storage pots (*mangay*) for drinking water; and vessels for washing clothes. The two brothers work full time as potters for the whole year; production decreases slightly from February to April because of the difficulties of drying pottery on rainy days. Any vessels that are ordered by traders are supplied from a stock kept at the workshop, so it cannot be said that the potters produce on order. They have no difficulty in selling all the vessels they can produce. Sometimes the brothers take vessels to a bazaar in Peshawar for sale, but usually traders come to their workshop with trucks to buy and take them away.

The workshop is combined with the potters' house, and in most respects is a typical Northwest Frontier Province potter's workshop. The only notable departure from the norm is the scale of the workshop and courtyard; the area is much larger because of the size of the vessels made and the extra space required for storing and drying them. The courtyard is enclosed by a mud-and-straw wall 3 m high. The potter's wheels are pit-wheels, similar to those of most workshops of the Northwest Frontier Province and the general techniques are within standard traditions of the Frontier potters; that is, forming initial shapes in a mold on the potter's wheel, finishing with paddle and anvil, and firing with dung fuel in an open kiln. Methods that are described from observation of other potters are thus only referred to briefly here.

Materials Gathering and Preparation

The potters of Musazi all use the same clay deposit, located near the village. All the potters dig their own clay, as opposed to buying from a specialist supplier. It is dug and transported to the workshops on donkeys owned by the potters. The clay is spread out in the potter's courtyard to dry for at least two days, and then lumps are broken up with a stick. The clay for a patch of body is then spread out on the ground in a hollow-centered conical pile; water is poured into the hollow center. When the clay is thoroughly wetted, sand, obtained by the potters from nearby sandhills, is added by spreading the sand evenly over the mound of clay. The proportions of sand to clay were one part sand to two parts clay, by volume. The sand and clay are then thoroughly mixed by foot-kneading. Body preparation to this stage is done in one afternoon; the body is always left overnight, covered with damp sacks, before use.

Forming and Finishing Techniques

Before beginning to make any pottery, the potter hand-kneads his clay using one of two different methods: The first is to remove clay from a stockpile by scratching off a layer about 3 cm thick with his fingertips, until enough is accumulated; form this into a rough cylinder; and, taking one end of this in his left hand, press the heel of his right hand into the center of the lump, forming a deep groove. The operation is completed by twisting the lump with the right hand to divide it in two, and raising the lump

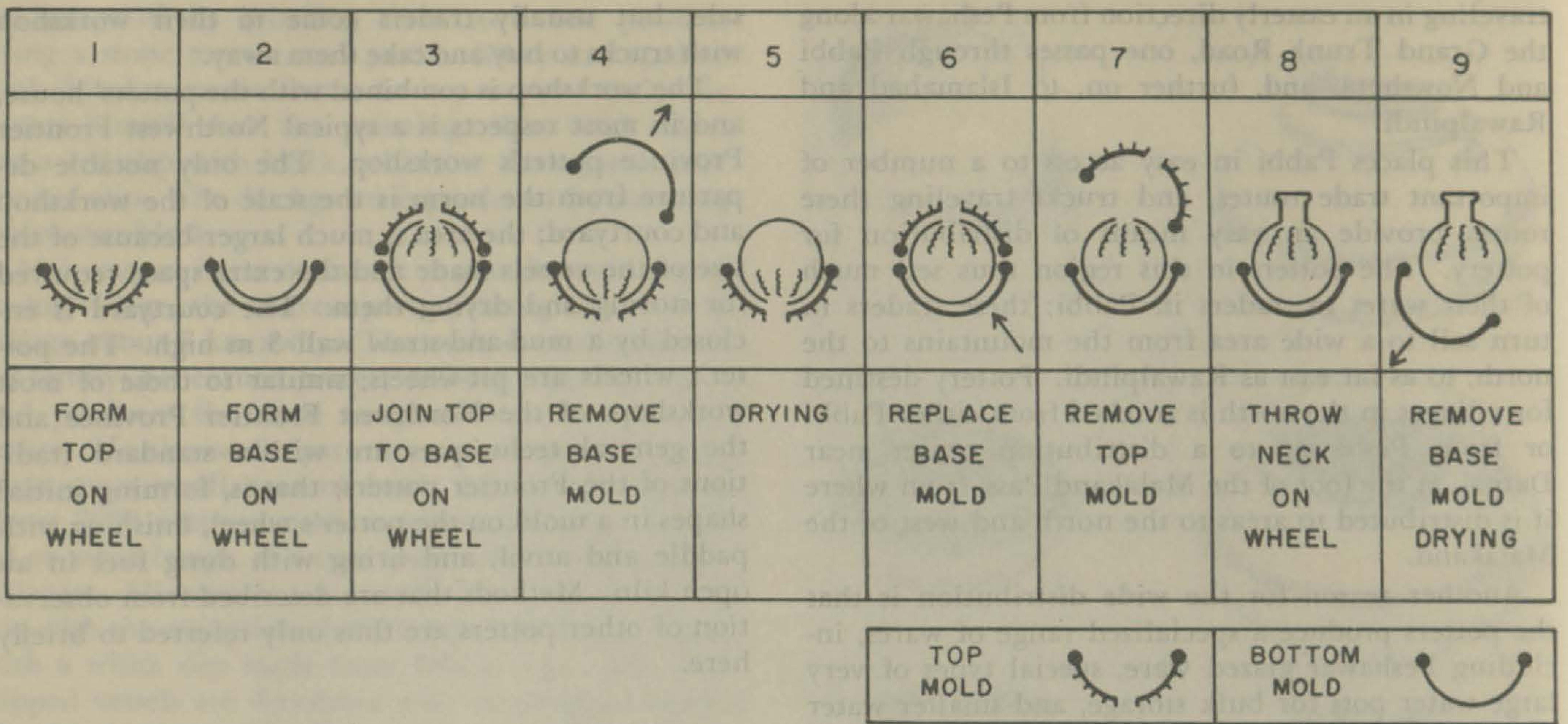


FIGURE 6.—Stages in forming a molded water pot (*mangay*) by potter Abdul Janab of Musazi, NWFP.

in his right hand, striking it down onto the half held in his left hand. The lump of clay is then again rolled into a cylinder and the operation repeated some 20–30 times. Kneading 5 kg of clay by this method takes only one minute.

The other method of hand-kneading is similar. When the amount of clay to be kneaded is more than can be held comfortably in the hands, the cylinder of clay is rolled out on the ground, or an a clay batt, on which sand has been sprinkled. Half the lump is torn off with his right hand, raised and struck down onto the other hand; the lump again is rolled to a cylinder and the operation repeated (Plate 21*a,b*). When the body has been kneaded by one of these two methods it is ready for use for making only smaller pottery vessels.

Clay is prepared by a different method for very large pots. The *mangay,* one of the most common vessel forms of all areas of Pakistan, is made in Musazi completely by molding. In most other areas this type of pot is made by first throwing a form in a base-mold on the wheel and then beating out the round base with paddle and anvil. The Musazi technique is basically an extension or refinement of the normal Northwest Frontier method of forming pottery vessels on the wheel using a base-mold for the base. Normally the mold is a hollow dish-shape, evenly concave; at Musazi this has been extended so that the bottom mold is hemispherical. Instead of throwing the top half of the pot, as elsewhere, the Musazi potters form the top half separately in another mold and then join the top and bottom together. The various stages in forming a *mangay* are shown in Figure 6.

The molds used are fired clay. The bottom mold, of which the potter had only a limited number, is smooth on the interior, and 18 cm in internal radius. The walls of the mold are 2 cm thick. The top mold, of which the potter had many, is also hemispherical, with the same radius and wall thickness as the bottom mold. The top mold has a pattern carved into the interior, which means that the molded vessel will have a raised band of decoration. The top mold also has a hole 9.2 cm diameter at the apex (Plate 22*c*). One man in the area is a specialist mold maker, and he supplies molds for the potters of Musazi and other nearby villages wherever they are used. Abdul Janab said, however, that sometimes he makes his own molds, and could do the carving, which normally is considered a specialist's work by other potters.

In making a *mangay* the top half of the pot is formed first. The potter places the top mold on a cloth pad resting on the wheelhead, and centers the mold. Then he forms a flat disc of clay (Plate 21*c*) by beating out a lump with his hands on a sand-dusted clay batt. The sand will later facilitate removal of the form from the mold. The flat disc is placed in the mold with the sand-coated side against the mold, and wetted slightly (Plate 21*d*). A circle of clay is cut out

of the "bottom" (which later will be the top of the vessel) with a knife (Plate 21*f*), guided by the sides of the hole in the mold. With the wheel revolving, the surface of the clay is then smoothed by pressing an anvil against it (Plate 21*g*). This operation insures that the clay is firmly pressed into the incised decoration of the mold. Excess clay, pushed up over the lip of the mold by the action of the anvil, is scraped off and replaced on the clay stockpile.

The top mold is then removed from the wheel and set aside so that the clay form inside can dry slightly. The bottom mold is then placed on the wheel and centered. The bottom half of the vessel is then formed in the mold in the same way as described for the top half, by smoothing and pressing the clay into the mold with an anvil. The excess clay, forced up over the lip of the mold, is not removed, however. It is trimmed so that about 2 cm of clay protrudes above the lip; this excess clay is then rolled inwards with the fingers to an angle of about 45°.

The top mold, with the top half of the pot still inside, is then placed in position on the bottom half. The potter then joins the two halves together (Plate 21*h*). With the wheel revolving slowly, he passes his hands through the opening in the top mold and presses the excess clay from the bottom half of the pot into the gap between the two halves. The, clasping both molds firmly together, he inverts them on the wheel so that the bottom mold is uppermost. He then removes the bottom mold, first tapping it firmly with the heel of his hand to free the pot, and then lifting it off (Plate 22*a*).

The pot, resting in the top mold, is then carried outside and left to dry to leather hard with the top downwards. The mold is propped up slightly with a stone to allow some air to circulate through the hole, thus allowing the top of the pot to dry. Immediately, the bottom mold can then be used with another top mold to form another vessel. Depending on the heat and breeze on a particular day, the potter can form 10 to 20 vessels before the first is dry enough to go on to the next operation.

When the vessels are dry enough, the potter replaces the bottom mold back in position on the bottom of the vessel. Holding both molds together, he inverts them and then for the first time removes the top half of the mold, being careful that the raised pattern is not damaged in the process (Plate 22*b*). The base mold, with the pot now resting right side up, is then placed back on the wheel and centered. The potter kneads a small lump of clay, about 1.5 kg, and forms a coil by rolling the clay vertically between his hands. He then joins this coil of clay to the circumference of the hole at the top of the vessel (Plate 22*d*). This coil is then centered and thrown to form the neck of the water pot (Plate 22*e,f*).

With the aid of an assistant, the water pot is then removed from the mold. With the assistant supporting the water pot and the potter holding the mold, mold and pot are inverted and the mold lifted off. The water pot is then placed outside in the courtyard to dry. Most of these are decorated when bone dry by dipping the top half in a white slip made from white clay bought commercially, probably originally coming from Gujrat.

Cātay, large water pots, are made basically by the method used in the Northwest Frontier for making any large vessel, that is, forming a flat base, placing this in a mold on the potter's wheel, adding a coil of clay around the circumference of the base, and throwing this coil to form the walls of the pot. Normally the bases of round vessels are then completed by beating with a paddle and anvil. Because of the large size of the Musazi vessels, two major variations on the basic technique are used: The first difference is that, during throwing, additional coils are added at the rim of the partly thrown vessel, the number of additions depending on the size of the vessel. The second is that, in view of the size of the vessel, the paddle and anvil technique is applied only to the upper walls of the vessel and not to the base. It is not possible to manipulate these large vessels into the positions used for beating out smaller vessels.

As with other vessels, the first stage of manufacture is to knead the clay. For smaller vessels this is done by hand-kneading, but larger ones require more clay than can be conveniently hand-kneaded, and so the clay is kneaded by foot, using the normal method of treading a lump until it forms a flat pile, doubling this pile over and repeating. The clay is finally wedged by hand for 10–15 cycles to insure its homogeneity (Plate 23*a*).

A bottom mold of the ordinary shape, concave but not hemispherical, is then placed on the wheelhead and centered. A flat disc of clay is then formed and placed in the mold. Abdul Janab has a distinctive method of transferring the flat clay disc to the mold; he places both hands, palm downwards, on top of the disc, and with a quick, lifting action transfers it to the mold (Plate 23*b,c*). The base for very large pots is placed in the mold with the aid of an assistant before the large mold is placed on the wheelhead.

The clay is smoothed into the mold and a coil of clay added around the circumference of the base disc. The coil is dampened with a little water, centered, and thrown to a truncated conical shape (Plate 23*e,f*), leaving the rim slightly thickened. A further coil of clay is then formed and joined to the semiformed

pot at the outside of the rim (Plate 23*g,h*). This coil is then centered and thrown as a continuation of the lower wall. This addition of coils and throwing is continued until the pot is the desired size. A vessel 0.6 m in height requires only one coil to be added; the largest ones, with a finished height of over 1 m, measure 0.5 m in the plastic state and require five additional coils. No drying time is allowed between the additions of coils, even with the largest pots. The potter joins another coil as soon as one is raised to the maximum height possible, and immediately continues the throwing.

The largest vessels are made in the same way as the smallest, but the level of skill required for the largest is very high. Throwing one of these is a major achievement for any potter; in demonstrating his skill Abdul Janab showed an outstanding degree of proficiency. The forming of one of these large pots is shown in Plate 25.

The finished shape on the wheel is still that of a truncated cone, with a thick rim. Before removing the vessel from the wheel the potter dusts the shoulder with sand (Plate 23*i*). The vessel is removed from the wheel by lifting it off still in the mold and carrying both of them outside the workshop to dry to a soft leather-hard stage. The largest vessels require two men to lift them from the wheel and carry them outside. An estimated 50–60 kg of clay body is used in forming the largest vessel, and the mold itself, 64 cm in diameter, weighs an estimated 7–8 kg.

After the pots are dried to a soft, leather-hard stage, they are carried back into the workshop, still in their molds. The potter uses a large paddle and anvil to finish the shape of the top part of the vessel (Plate 24). Standing upright in the mold, it is revolved a little at a time by pushing gently inside with the anvil after each blow of the paddle. This means that the shape is evenly and constantly modified until the sides are more or less parallel, with a distinct rounded shoulder. The mold and pot are then placed back on the wheel, and the vessel polished with the wooden paddle while slowly revolving the wheel. A band of decoration is then applied on the shoulder. The potter first applies a fine band of plastic clay, and then smooths this with the wheel revolving slowly. He then applies decorative scallops, spaced about 1 cm apart, with the side of his little finger (Plate 24*f*). Then, the vessel is carried outside, removed from the mold, and placed upside down for drying. With the smaller vessels the potter works on a batch of 15 to 20 together, the number depending on the drying rate on any particular day. He throws until the first is ready for paddling, and then beats out the shape of all; then he removes them all from the molds at once. The next stage is to trim the bases of all the pots with a hooped iron tool to remove the seam left at the point where the wall of the pot meets the rim of the mold. At this point all forming stages of the vessels are complete. They are then left outside for two to three days to dry to a bone-dry texture and then stacked in a convenient spot to await firing. No slip or pigment is applied to this particular type of vessel.

Firing

The kiln used by Abdul Janab is described as *pajā*, but it is actually more closely related in type to the Panjabi *āvī* (Figure 7, Plate 26). The structure is simply a trench about 3 m wide and 10 m long, excavated to a depth of about 30 cm. Mud-and-straw walls, 50 cm thick, are built along three sides of this trench to give an open-fronted structure.

The fuel used is dung. The kiln is fired only twice a year, and each firing uses 40 donkey loads of dung, each load weighing about two maunds. Thus, the total annual usage is about 160 maunds (about 7000 kg) of dung fuel.

In each firing there are 500 vessels, according to the potter; 200 smaller and about 300 of the larger water pots (*cātay*). The potter said that occasionally when the demand is great, he fires only the largest pots, or about 400 to the firing. The total sale value of pots from a single firing is about 600–650 rupees.

In setting the kiln, the potter first sets a layer about 0.5 m thick of dung cakes. This layer is thicker at the back of the kiln so the setting of pots slopes upwards at the back. Then a layer of large pots is set, each pot upside down and the spaces between them filled with small pieces of dung. Further layers of pots are set, the large pots at the back of the kiln and smaller pots at the front. Finally the entire setting is covered with another layer of dung. The setting takes a full day from beginning to end. The fire is started at the front of the kiln with some small pieces of wood, and takes two days to burn out completely. The potter is careful to select a time for firing when there is no likelihood of rain, as rain, when the vessels are hot, can mean the loss of most of them due to too rapid and uneven cooling, and hence the loss of six month's work.

Types of Pottery

As outlined above, the limited range of pottery types from this area is restricted to three types: vessels

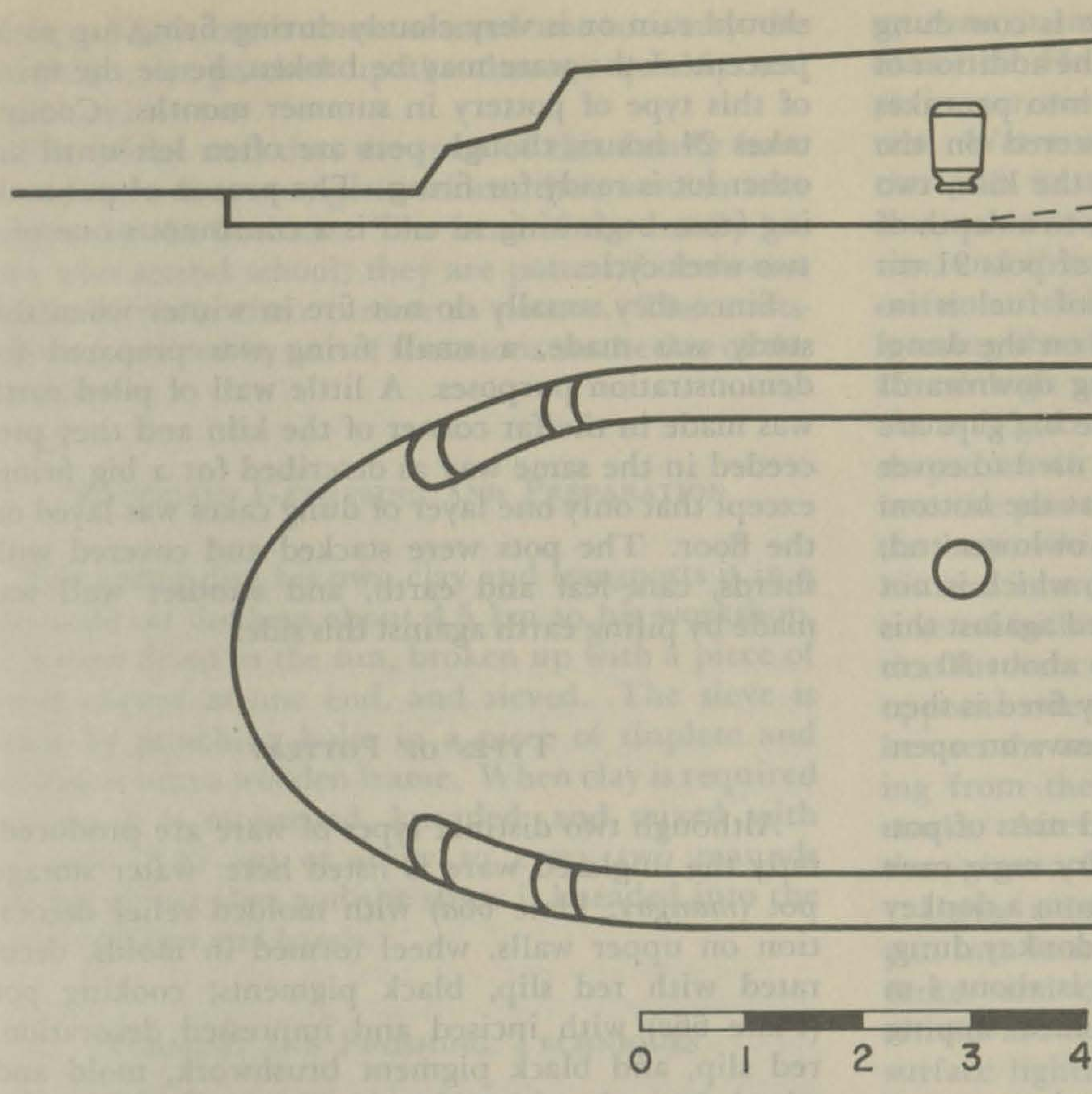


FIGURE 7.—Side elevation (*above*) and plan (*below*) of Musazi potter Abdul Janab's kiln. Sloping floor indicated by broken line in elevation. For comparison the size of a large water pot is indicated to scale. (See also Plate 26c.)

for washing dishes, and two types of water pots, *mangay* and *cātay*. The latter is made in four sizes: largest, 51 cm in diameter and 76 cm in height; two intermediate sizes, 38 cm in diameter and 66 cm in height, and 30 cm in diameter and 48 cm in height; and smallest, 23 cm in diameter and 38 cm in height.

The *mangay* is normally 30 cm in diameter and 27 cm high, although larger sizes are made; and the vessels for washing dishes are about 45 cm diameter and 8 cm high.

ZAKHEL BALA, NORTHWEST FRONTIER PROVINCE

Unglazed pottery is made in the village of Zakhel Bala near Peshawar. Studies were made in the workshop of Hassan Din and Roshan Din. In addition to unglazed vessels, these potters make glazed ware (pp. 77–86), which is their primary product. Since only the firing technique is unique, the comments on tools and equipment, materials gathering and preparation, and forming and finishing techniques are not reported.

FIRING

The firing for unglazed vessels is completely different to that for glazed ware. A firing of unglazed ware was seen by R. Wulff in 1968. The following outline is taken from her report:

The kiln for the unglazed ware is just an area in the corner of the courtyard, with a mud wall forming a third side. The area is about 4 m long by 2.5 m

wide. The fuel used for unglazed ware is cow dung (*sapyāka*), which has been prepared by the addition of about 15 percent of straw and patted into pancakes of about 20 cm in diameter and plastered on the sunny sides of walls to dry. In setting the kiln, two layers of dung cakes are stacked on edge to a depth of about 30 cm—this suffices for a setting of pots 91 cm deep. If more pots are set the depth of fuel is increased. Pots are then set upside down on the dung. They are stacked on their sides, facing downwards and leaning against one another. Where big gaps are created by bulbous forms potsherds are used to cover the gaps. The biggest pots are stacked at the bottom and the smaller at the top. At the front, or lower end, the pots themselves form the front wall, which is not very high, and one layer of dung is packed against this end and also over the top of the pots to about 30 cm depth. A last layer of pots already partly fired is then put in front of this in such a way as to leave an opening where the fire is started.

The roof of the kiln consists of a solid mass of potsherds (*ḍakara*) followed by a layer of dry sugar-cane leaf, and this is covered with scrapings from a donkey shed comprising a mixture of dry earth, donkey dung, and straw. The total area of the setting is about 4 m long, 2.5 m wide, and 2 m high at the back, sloping down to 60 cm at the front.

The upper layer of cane leaf and dung burns away during the firing, leaving only the insulating earth cover. If holes in the top covering layers during firing, potsherds are placed over the holes. The firing is started at night and takes 36 hours, during which time the whole mass sinks slowly as the fuel burns away. If stacking in any area is slack, cow dung cakes are packed between pots. In the firing of 800 pots, breakage is about 60. If any pots are not fully fired but not broken, they are put into the next firing. If it should rain or is very cloudy during firing, up to 50 percent of the ware may be broken, hence the firing of this type of pottery in summer months. Cooling takes 24 hours, though pots are often left until another lot is ready for firing. The process of pot making from beginning to end is a continuous one of a two-week cycle.

Since they usually do not fire in winter when this study was made, a small firing was prepared for demonstration purposes. A little wall of piled earth was made in the far corner of the kiln and they proceeded in the same way as described for a big firing, except that only one layer of dung cakes was layed on the floor. The pots were stacked and covered with sherds, cane-leaf and earth, and another wall was made by piling earth against this side.

Types of Pottery

Although two distinct types of ware are produced, only the unglazed ware is listed here: water storage pot (*mangay;* Plate 66*a*) with molded relief decoration on upper walls, wheel formed in molds, decorated with red slip, black pigments; cooking pot (Plate 66*c*) with incised and impressed decoration, red slip, and black pigment brushwork, mold and wheel formed, with lid, wheel formed; dishes for serving rice foods, flour dishes in which *nan* (bread dough) is allowed to ferment, feeding dishes for cattle (*kanale*); water pitcher (*kūzā*) with spout (Plate 66*b*), decorated with red slip; spice dishes, small bowls, also used for serving individual portions of salads (the "salad" served one vegetable only to each dish), undecorated; and hookahs (*cilam*), formed the same as glazed hookahs but fired without slip or glaze, incised decoration, vertical fluting.

PRANG, NORTHWEST FRONTIER PROVINCE

Pottery making was studied in the village of Prang by members of the Ancient Technology Project in 1969. This outline is an edited summary of their report, without Rye's firsthand field observations. The potter, Shah Pasand of the village of Prang, 32 km north of Peshawar, makes every type of clay article the market demands. He is the head of one of eight potter families in this village of 12,000 people. The craftsman's courtyard is his workshop. It has mud brick walls 2 m high, and a hard earth floor scattered with straw, sand, chicken droppings, drying vessels, fired pottery, and potsherds. The ground is his bench; the short mud brick wall, which forms one side of the kiln, is piled with cow and donkey dung ready for the next firing. His wheel is at ground level, set into a pit into which he places his legs as he sits astride the top crossmember. This particular wheel was not in use at the time of our observations.

A stall with several donkeys and a calf stands at one corner of the courtyard, and some half dozen chickens roam freely about. In our presence, two donkeys, brought in loaded with new wet clay, trampled drying sugar pans, and the chickens tore up a newly made mill-lining that was standing ver-

tically. These occurrences seemed not to worry the craftsman; he patched up the damage quickly and cheerfully.

The potter said that the men of this family have been potters for many generations; their women take no part in the business. The head of the family has sons who attend school; they are potters, but do not expect to make their careers as potters. The craftsman was assisted by one of these sons on the day of the interview.

Materials Gathering and Preparation

The potter digs his own clay and transports it in a wet state on donkeys about 4.5 km to his workshop. It is then dried in the sun, broken up with a piece of wood curved at one end, and sieved. The sieve is made by punching holes in a piece of tinplate and nailing it into a wooden frame. When clay is required for use it is moistened, kneaded, and mixed with 0.5 seer (0.45 kg) of straw to every two maunds (90 kg) of wet clay, and the straw is kneaded into the mass with feet and hands.

Forming and Finishing Techniques

Forming techniques, not requiring the use of the pit-wheel, were observed for the making of *atra* (sugar pans) and *cak* (well liners).

Atra.—This circular, flat pan, or tray, is used in sugar-cane processing, for cooling the boiled, thickened juice obtained from crushing the sugar cane. It has an unbroken lip or wall some 10 cm high, standing at right angles to the smooth base and is about 2 cm in diameter. It is not glazed or decorated in any way. Two maunds (90 kg) of the prepared clay are required for one pan. Dark, micaceous sand, brought from the nearby river, is scattered by hand over an area of ground about 1 m in diameter to a depth of 1 cm. The craftsman spreads about one maund of the clay in a pile in the center of the sand and begins spreading the clay with his feet. First, he trods all around the clay with his feet pointed toward the top of the lump. Then he works his way up until the top forms a plateau. He spreads the homogeneous mass into a disc 1.5 m in diameter and about 3 cm thick. At this point, stepping off the clay, he uses his hands in a patting motion to flatten and further increase the diameter. If the base spreads out irregularly, he takes clay from one point on the perimeter and attaches it to another, or simply adds new clay. At no time does he set out a pattern for his circle. He then takes more clay and rolls and squeezes it into coils about 40 cm long by 5 cm in diameter. He places these, one at a time, around the perimeter, resting on the base, to form a sausage-like rim. Water is then sprinkled on a portion of this rim and its neighboring area of base. He squats close to his work. With a hand on each side of the rim, and thumbs overlapping on its top surface, the craftsman slides his hands backwards and forwards, forming the slippery clay into a thick side wall some 10 cm high and 4 cm wide at the base, tapering to about 2.5 cm at the top. Using a wooden mushroom-shaped anvil, the craftsman reaches at arms' length into the pan and holds it as he paddles the surface of the base, which he sprinkles with water. He moves his arm in arcs until about half the total base area is covered with overlapping paddle marks. This operation further compacts the clay. It is repeated from the opposite side of the pan. When all the base is paddled, he uses the anvil in sweeping arcs, with his arms moving from the shoulder, to smooth out the paddle-marks. After sprinkling once again with water, he then gives a final smoothing with his hands.

Using a large knife the craftsman then cuts the pan into four equal sections, starting each cut in the center and cutting outwards to the rim. The incisions are then covered by smoothing over the pan surface lightly with his hands. This is done to prevent excess drying and subsequent warping of the cut edges. After about four days in the sun, the pan shrinks sufficiently to open these cuts some 1.5 cm. When six days drying time has elapsed the four segments are stacked vertically until 15 sets, enough for a firing, are completed. While the clay is still wet, the four segments of a set are marked to identify the set of which they are a part, and their position in that set. Any cracks that appear during the drying process are opened by chopping them with a spatula and, after wetting, are filled by pressing in surrounding clay and new clay and smoothing over.

The potter sells a complete *atra* for 10 rupees and makes two a day on the average during October and November each year; this is the period just before the sugar harvest. At the sugar processing plant the *atra* is assembled in correct position on the ground and held in place by means of wooden pegs driven into the earth at various points on its circumference. Thick sugar syrup from the first batch to be poured in serves to fill the cracks and seal the joints.

Cak.—These well linings are porous earthenware cylinders some 0.6 m long and approximately the same diameter. They are very slightly flared at the top and in use sit, one on top of another, with a shallow U-shaped cavity about 7.5 cm long and 2.5 cm deep at two opposite points in the top rim.

These cavities are used as hand- and foot-holds for anyone climbing down the well. Since these cavities are opposite each other and only 0.6 m apart, it is possible for a man to stand half way down the well, with feet apart at the same level, in order to carry out repairs. *Cak* are fired in two halves for economy of space in the kiln. As a rule they are not made during the month of Ramadan, but the potter agreed to demonstrate the process for us during that period, since the field party could not change its scheduled itinerary.

Cak are made in two halves, joined and then cut in half again for firing. Each half is made the same way. Two woven palm mats, rectangular in shape and approximately 1 m by 0.6 m are placed on the ground and about half a maund (45 kg) of clay is piled on each. Working on one mat, with his son working on the other, the potter beats the clay with his hands to spread it to the edges of the mat, leaving a strip (8 cm wide) of the mat bare along one of the short sides. He takes surplus clay from one edge and adds it to another as required. The slab of clay is beaten until it is about 4 cm thick at one of the longer edges of the mat tapering to about 1.5 cm at the opposite edge. Both mats are covered in this way. Then they are stacked carefully on their thicker edges and curved to meet each other, mat side outwards and overlapping along the bare strip of mat at each joint. The joints on the inside of the cylinder are bonded together by smearing the clay, adding water and a little more clay, when required. The mats are then carefully peeled off the outside surface, easing them away from the clay and patting it smooth. The outside joints are smoothed in the same way as the inside ones. The cylinder is then straightened by beating with the palms, and brought to an even, round shape by beating from the inside, so that the base moves slightly along the ground in the places where adjustment is necessary. A coil of clay is then pressed down over the thinner top edge and rubbed backwards and forwards with wet hands to form a thick rim. The top of the *cak* is flared slightly at this stage. The potter explained that shrinkage in drying is greater at the top (thin-walled) end than at the base. The top is flared so that after drying is complete the walls of the well-liner will be straight. He also said that if "better" clay is used the flaring is unnecessary.

Taking his large knife, the potter then makes cuts at the places where the two halves are joined. The cuts extend from 5 cm below the rim to 5 cm above the base, so that the halves are still joined at the extremities. The halves are marked for identification as a pair. After drying in the sun for some time, these last joints are cracked open. The *cak* is dried for one or two days before the footholds are cut out. After six days of total drying time it is ready for firing.

Firing

The *atra* and *cak* are fired in an open kiln with dung-and-straw fuel. Fifteen sugar pans or 12 well liners can be fired at one time. In either case the total firing time is three days. The pieces are stacked vertically in the kiln.

Types of Pottery

All the ware seen at this workshop was red earthenware, unglazed but decorated occasionally with a black manganese slip. Products included: large flat pans for sugar cooling; grain jars; small ovens; butter churns; narrow-necked water pots; and well liners.

KHARMATHU, NORTHWEST FRONTIER PROVINCE

The village of Kharmathu is 9.6 km south of Kohat along a track leading from the main Kohat to Bannu highway. In 1971 there were five pottery workshops in the village, all of which produced a similar style of pottery made from identical materials. Much of the pottery produced in Kharmathu is taken to a pottery bazaar in Kohat where it is retailed to people living in Kohat and other villages in the district.

The workshop included in this study is operated by four brothers: Sher Zaman, Waris Khan, Noman Khan, and Zaman Khan. All of the brothers are *kumhār* (professional potters) and learned their craft from their father. Their grandfather was born in Kashmir, had moved to Kharmathu at an early age, and the potters did not know if their family before their grandfather had been potters.

The workshop operates throughout the year but production varies seasonally. One potter said that they work an average of 11 hours a day in the summer, but that this is reduced to an average of four hours a day in winter. In the winter they only make small vessels, because of the difficulty of drying larger vessels

during this period. The weather is less predictable in winter and firing also becomes a risk when there is a possibility of rain.

One of the potters is unmarried but the other three live with their families in a large living area included at one end of the large enclosed courtyard which surrounds the workshop area. The entire workshop is at the edge of the village so that other villagers will not be affected by the smoke from firing, and because the potters have easier access to their clay deposits. Women and children of the potter's families assist with some tasks in the workshop. The women are responsible for drying vessels and insuring that they do not dry too quickly or too completely, by moving the vessels to different areas of the courtyard. The children assist with unskilled work, such as carrying clay from one place to another. The assistance varies from day to day and is not strictly defined; sometimes when the women and children are otherwise occupied the potters take over these tasks themselves.

Materials Gathering and Preparation

Clay for pottery making is dug by the potters at a deposit 5 km from the workshop. The deposit consists of a layer, varying in thickness, spread over a wide area of land (Plate 27*a*) that is cultivated on a fallow system. The potters obtain their clay from the land laying fallow so the specific site of the deposit varies from year to year. They do not dig deeper that 1 m, because this would leave large holes in the land, but clay extends down below this depth. The top layer of about 0.2 to 0.3 m is rejected as overburden. The clay is obtained free from cost since the potters are the landowners.

The clay is dug every three to four days by one of the potters who goes to the site with a donkey. Four donkey loads or approximately 300 kg of clay are dug and transported to the workshop in one day. This amount of clay is sufficient to supply the four potters at their daily rate of consumption in the summer.

When the clay (*mittī*) is brought into the workshop it is dumped in the courtyard and spread out so that larger lumps containing moisture will be dried by the sun. The lumps are then further broken up by pounding with the back of a shovel, and the clay is sieved through a sheet metal sieve (*paroṇā*) with apertures of approximately 1 cm punched into it (Plate 28*e*). The clay is sieved onto mats woven from *mazrī*, made of leaves of the dwarf palm (*Nanhorrops ritchieana*). It is then ready for use in preparation of the body.

Sand (*rat*) for the body is dug from sandhills near to the workshop and transported to the workshop on donkeys. It is also sieved before use. The sieve for sand (*paronī*) is made from sheet metal in the same way as the sieve used for clay, but with smaller apertures, averaging only 10 mm. The sand grains are finer than 10 mm, so only unwanted organic and other contaminants are removed by the sieving. The sand is sieved into large dishes so it can easily be moved from one place to another in the workshop (Plate 28*d*).

Salt (*loṇ*) is also used in the pottery body. The raw material is common salt (NaCl), bought in the bazaar in block form, and normally used for domestic consumption. The salt is prepared by breaking up the lumps (*vaṭṭā loṇ*, "block salt") in a mortar (*langrī*) and then grinding the finer product in a stone quern (*cakkī*).

The clay body is prepared in an enclosed room to one side of the workshop courtyard. Every day during the working season, the body is prepared in a trough, which is excavated in the earthen floor of the room. The rectangular pit (*pīṛā*) is 15 cm deep, 1.7 m long and 1 m wide, and slightly rounded at the corners. It originally was larger, but in use a layer of clay has built up on the surfaces. This prevents contamination of the clay body by earth from the floor.

Clay is placed in the pit and spread evenly to a depth of about 15 cm. It is then moistened with the minimum amount of water to bring it to plastic condition in about 15 minutes. The potter then sprinkles salt over the clay, and leaves the materials until the salt is dampened by the water already mixed with the clay. The salt does not dissolve because individual grains are still noticeable.

When the clay and salt stand for another fifteen minutes and both are moistened evenly, the clay is kneaded by treading it with the feet. Sand is added at this stage; the potter sprinkles sand in a thick coating over the clay before he begins to tread the mixture, and more sand is added from time to time as the kneading proceeds. When the mixture is sufficiently even that lumps of body can be picked up, portions of about 7 or 8 kg are removed and kneaded by hand. More sand is sprinkled over each lump before it is kneaded.

The amounts of the three materials blended together for the body are determined by the potter's judgment rather than by any quantitative method, so an exact body composition cannot be given. It is estimated by Owen Rye that the materials are blended in the following proportions: clay, 75 to 90 percent; salt, 5 to 10 percent; and sand, 5 to 15 percent by

weight. Because of the method of judging the amounts of ingredients, it can be assumed that the body composition will vary considerably from batch to batch; the main significance of this variation is in the discussion on firing at Kharmathu (p. 41).

The clay body, which is prepared but not used immediately is stored in an underground circular pit (*sarā*), about 1.5 m deep, tapering from 0.7 m diameter at the top or ground level to 2.4 m in diameter at the base. This storage pit is used more often when the weather is variable. Since the pit can be covered with a wooden lid to preserve the damp atmosphere inside, it is also used during the hottest part of the year for drying vessels, which would otherwise dry too quickly in the open air.

Forming and Finishing Techniques

The potter's wheel is used to shape the initial form of all vessels made in this workshop. Several pit-wheels are placed in a covered area at one side of the open courtyard and adjacent to the living quarters. The pit-wheel (*dukān*) is of the basic type previously described (p. 17). The flywheel (*cak*), 46 cm in diameter, of one wheel has been in use for the lifetime of all the potters, or at least 30 years. The lower bearing is a steel pin (*makh*) which runs in a ball-bearing set into a piece of wood at the base of the pit (*ṭoā*). This ball-bearing is a recent innovation, but the basic design of the wheels has remained unchanged in the potter's lifetime (Plate 27).

Some of the vessel types made at this workshop are finished on the potter's wheel, including the flower pots (*gamlā*), the small *surāhī*, and the garden pots (*nalkā*). Other vessels are thrown, and after drying to leather hard, turned. These include bowls (*bakhorā*), water carrying flasks (*cāhirī*), and water pitchers (*kūzā*). The latter two require the joining of other parts, such as spouts and necks, in addition to the turning. Water pots (*gharī* and *maṭṭī*) are formed by a third method, where an initial form is thrown on the potter's wheel, completing the upper (neck and rim) part of the vessel, but leaving a thick base that is later completed by use of paddle and anvil.

The large water pots begin with a lump of clay (*pinnī*) placed directly on the wheelhead (*ṭopaī*). The potter has to work carefully when throwing, since the body has a tendency to form splits or cracks (*fuṭ*) if the throwing is too rapid or if the form is opened out too much. This splitting tendency may be due to the inclusion of salt in the body. The salt grains dissolve, possibly forming voids and localized areas of deflocculated clay.

When the initial form (Plate 28*c*) is completed it is cut from the wheelhead with a piece of thread (*dhāgā*) held taut with one end in either hand and pulled straight through underneath the vessel. The soft (*sīnā*, "plastic clay") vessel is then carried outside to dry to leather hard (*vatar*).

The wooden paddle (*tātī*) and fired clay anvil (*kunerā*) are used in the same way as has been described elsewhere (Plate 28*a*) for the Northwest Frontier Province. The potter keeps the paddle face slightly moist by occasionally rubbing it against a wet cloth while working. The splits that appear in the vessel walls of the initial form during throwing are closed now by the paddling operation, although some of the split areas on the vessels cause problems when they open up into large cracks. When this occurs the potter pastes a small lump of plastic clay over the cracked area and blends it into the form by continuing the paddling.

Decoration

The potters at Kharmathu use three decorative techniques: Some vessels are decorated on the wheel immediately after throwing is completed, with incised bands applied with a pointed tool while the wheel is revolving. Some of the large water pots receive the second type of decoration, pastilles of plastic clay applied as relief on the surface, spaced widely apart in bands. The third type of decoration is the application of slip to bone-dry (*sūkhā*) vessels. The slip is made by placing some of the body clay in a dish and adding water. The clay slakes readily to form a thick slurry about midway in consistency between an ordinary liquid slip and the plastic body used for throwing on the wheel. It is unusual compared to other described slips found in Pakistan in that its composition is exactly the same as that of the body to which it is applied. It is applied to dry vessels by scooping up handfuls of the thick slip and rubbing it onto the vessels in bands. One of the potters said that it is only applied to large water storage pots, because the people who buy the vessels believe that if they are treated this way the water kept in the vessels will be colder than that kept in an unslipped vessel. He said that he keeps water in both unslipped and slipped vessels in his home and that he cannot tell the difference, but he still produces slipped vessels because that is what the customers want.

A brief examination of some broken vessels that were coated with slip and then fired show that the surface layer is more vitreous than the main body of the vessel. This increased vitrification could have

occurred during firing as a result of the chemical reaction of other body constituents (particularly, fine silica) and salt crystals, which were formed as the porous slip dried. Vessels that are not slipped show increased vitrification on the surface only, with no coarsely porous layer. It is possible, therefore, that the vitrified, small-pored surface of unslipped vessels is less permeable than that of the coarsely porous slipped vessels. If this is the case, then the slipped vessels may allow water to evaporate more quickly at the surface. This physical difference between unslipped and slipped vessels is in accordance with the villager's belief that vessels with slip keep cooler the water stored in them.

Firing

The kiln used by the Kharmathu potters is an open pit kiln of the typical Panjabi *āvī* type. The firing area is an exposed hillside behind the potter's workshop, situated at one extreme edge of the village. This hillside continues as a straight ridge some 5 km long, which acts as a windbreak for the entire village. In the firing area three pits were constructed by the potters. In 1971 one of these was not in use, but the other two were used alternately for firing. The hillside slopes upwards quite steeply with a rise of approximately one in six, giving a strong up-draft to the kiln.

One of the kilns is shown in Plate 29. All three kilns (*avāvī*) are similar in size; the width of the pit across the hillside is 3.7 m and the length of the pit from front to back up the hillside is 4.6 m. The perimeter of the pit has been built up with earth to provide a low wall (*bannā*). The maximum depth of the pit from the level of the top of the walls to the lowest floor level is approximately 1 m. The overall shape is similar to that of the pit kiln from Shahdarah shown in Figure 13. The narrow lower end of the pit (*durrā*, "firemouth") is filled with rounded pieces of rock about 15 cm in diameter to provide a passage of air to the front of the setting.

After a firing, the floor (*tāle*) of the pit kiln is littered with sherds, pieces from vessels that were damaged during the firing (Plate 29). The first stage of setting is to sweep all these sherds over to the sides of the pit. Thus, the area around the kilns is strewn with a layer of sherds that have been accumulating for many years. When questioned the potters said that no use has been found for this material; it could be used for building but stone is easily obtained in the district.

After sweeping off the floor of the kiln, the next stage of setting is to place a layer of straw (from the mustard seed plant, *Brassica campestris;* vernacular for the straw *sarsõ kā bhõh*) on the floor of the pit. Twigs from an unidentified scrub bush, which grows wild around Kharmathu, are mixed with the straw. The twigs (*lashat*) are dried before use. This base layer of twigs and straw is trampled down to a final thickness of about 25 cm. The next layer consists of mixed wood (*lakṛī*) scraps. This wood is bought from fuel suppliers and is used by other villagers for heating and cooking. Individual pieces of wood are from 5–10 cm in diameter and about 1 m long. The pieces of wood are placed in rows, each row about 15 cm apart. Only one layer of the wood pieces is set. Dung cakes (*gohā*) are packed between the rows of wood.

The vessels are then placed on top of these two base layers of fuel. Larger pots are set at the bottom and smaller vessels between, or on top of the larger, with all vessels set upside down. When all the vessels are placed in position, a layer of wheat straw (*nāṛ*) about 15 cm thick is spread over the pots. Much of the straw falls down between the pots initially but the potters add more until the vessels are evenly covered. Where a large gap occurs it is covered with a large sherd before the straw layer is started.

Broken pieces of dung (*pāh*) are then used to form another layer over the straw. The layer of dung pieces is only about 8 to 10 cm thick. This completes the setting; the final setting is approximately level with the top of the perimeter walls of the pit kiln.

The potters start the firing (*āg balṇī*, "fire to burn") by lighting a small fire of twigs at the front or firemouth end of the kiln. The fuel is consumed in 8–10 hours depending on climatic conditions, and the fired vessels can be removed 24 hours after the firing commences.

One kiln is fired every two weeks if all four brothers are producing at full capacity. Each firing contains some 400 vessels. Average firing losses are 25 percent, but one potter said that a firing loss of 50 percent is not uncommon; and in the past when there was unexpected rain almost all vessels from a firing were damaged. Inspection of sherds at the site, and damaged but usable vessels stored at the workshop, show that the vessels are exposed to very uneven heating conditions through the setting. Sherds show the typical range of colors characteristic of unglazed earthenware produced from a clay body containing salt, from red to yellow and light to dark green.

In that order the color changes correspond to increasing temperature of heating, and to a less pronounced extent under practical conditions increased time of heating. As a generalization, it can be stated that the red colors correspond to firing temperatures below 800° to 900°C and that the dark

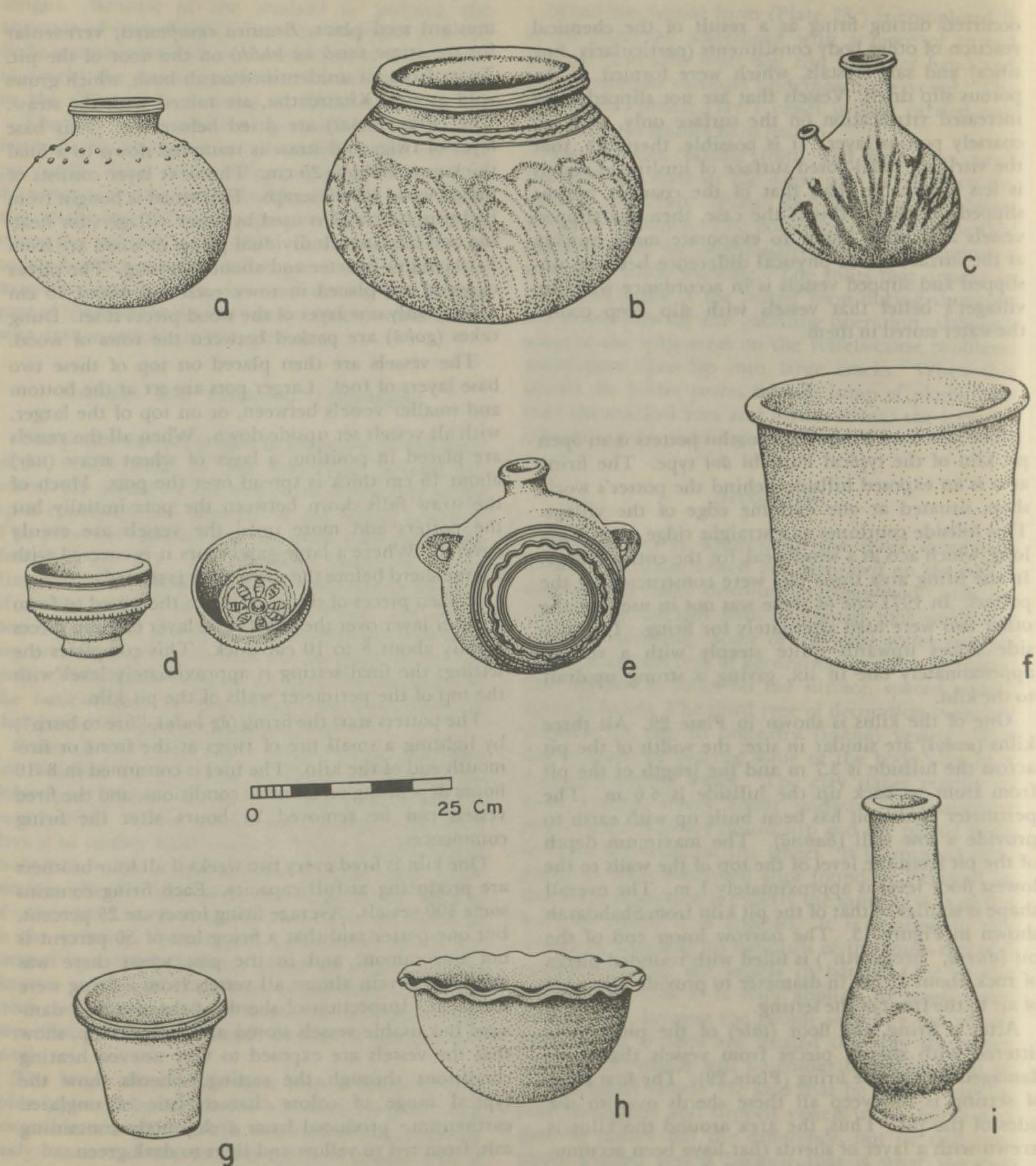


FIGURE 8.—Vessel types from the workshop of Sher Zaman and family of Kharmathu, NWFP: *a*, water pot, for carrying; *b*, water storage pot; *c*, ewer with spout; *d*, profile and top view of bowl for drinking; *e*, water flask ("pilgram flask"); *f*, large flowerpot for shrubs; *g*, small flowerpot; *h*, flowerpot or vase; *i*, garden pot.

green colors are not normally formed by temperatures below 1000° to 1100°C. The yellow and green colors indicate the beginning of vitrification, and vitrification is usually extensive where the body was fired to a dark green color. It is obvious that the method of setting the Kharmathu kilns results in wide temperature fluctuations within the setting. In some cases the temperature variation across one vessel in the setting is wide enough to cause one side of the vessel to be satisfactorily fired but the other side to distort and warp badly from excessive vitrification. A case of the latter is shown in (Plate 29*d*), where the rim of a water pot was distorted by pressure from the point where it was resting upside down on another vessel. This rim is extensively bloated from overfiring. In summary, the relatively high firing losses sustained by the Kharmathu kilns is due to uneven heating conditions in the setting; this causes occasional extensive overfiring of vessels. Because the body contained common salt (that is, NaCl), which in reaction with other constituents of the body causes extensive vitrification, many vessels become pyroplastic at high temperatures and are deformed by the pressure of other vessels against them. The pit kiln has no provision for controlling heating rate other than in the initial setting, so the losses are an inevitable result of firing for the Kharmathu potters.

Types of Pottery

Vessel types produced by the Kharmathu potter are shown in Figure 8. The major products are referred to in the following listing: water pot (*gharī*) for carrying water (Figure 8*a*), small size 28 cm diameter, decorated with two bands of applied fillets evenly spaced around the shoulder; water storage pot (*maṭṭī*), also used for milk storage (Figure 8*b*), 41 cm diameter decorated with incised bands on shoulder and rim, coarse slip of same composition as clay body applied to sides and base of vessel and decorated with rhythmic vertical bands applied with fingertips in soft slip (finger-combing); ewer (*kūzā*) used for ritual ablution and also to contain drinking water, 20 cm diameter, decorated with finger-combed slip of same composition as clay body, applied to base and sides of vessel (Figure 8*c*); drinking bowl (*bakhorā*), diameter 10–15 cm, incised bands and impressed decoration on exterior, incised bands and incised floral motif on interior, turned foot (Figure 8*d*); water flask or "pilgrim flask" (*cāhirī*), maximum diameter 20 cm, pierced lug handles, decorated with incised circular bands on front surface (Figure 8*e*); flowerpots (*gamlā*), large size for growing shrubs, 32 cm diameter across rim, undecorated (Figure 8*f*); small size for growing flowers, 15 cm diameter at rim, undecorated (Figure 8*g*); and type for interior or decorative use with flower arrangements, 30.5 cm diameter across rim, decorated with scalloped rim (Figure 8*h*); garden pot (*nalkā*, in Urdu and Panjabi means "tube") for decorative use in formal gardens, open at both top and bottom, height 39 cm, undecorated on exterior or interior (Figure 8*i*).

BANNU, NORTHWEST FRONTIER PROVINCE

The city of Bannu is 130 km to the south-southwest of Peshawar, easily accessible by a macadam road from Peshawar via the Kohat Pass and Kohat. The Afghanistan border is some 50 km to the west of Bannu. Bannu is in tribal territory; the city itself is walled with entry and exit regulated through gates. A large market in Bannu is the exchange point for the produce of the many small surrounding villages, the results being that the market shows samples of all pottery types made in the Bannu district. The potters normally take orders for specific vessels from members of their own village, thus having their own localized market, and also produce wares that can be sold through the larger market in Bannu. Shopkeepers in the Bannu market purchase vessels directly from the village potters, usually in large lots such as a wagon-load, paying cash for the pots. The vessels are then sold individually to both city and village dwellers; thus, any village household in the district may have pottery from anywhere in Bannu district.

Two potters were observed in the Bannu district, in the villages of Shahbaz Ahmed Khel, 10 km to the southeast of Bannu city, and Durar, in the Bannu District by Godden in 1969 (ATPR, 1967–1971).

Village of Shahbaz Ahmed Khel

The potter Mir Shad has one of the 15 workshops in this village. The other workshops are producing vessels similar to his. Mir Shad has no male assistants and is the only potter in his workshop. He is assisted by women and children in his family, who usually do the unskilled work of carrying pottery

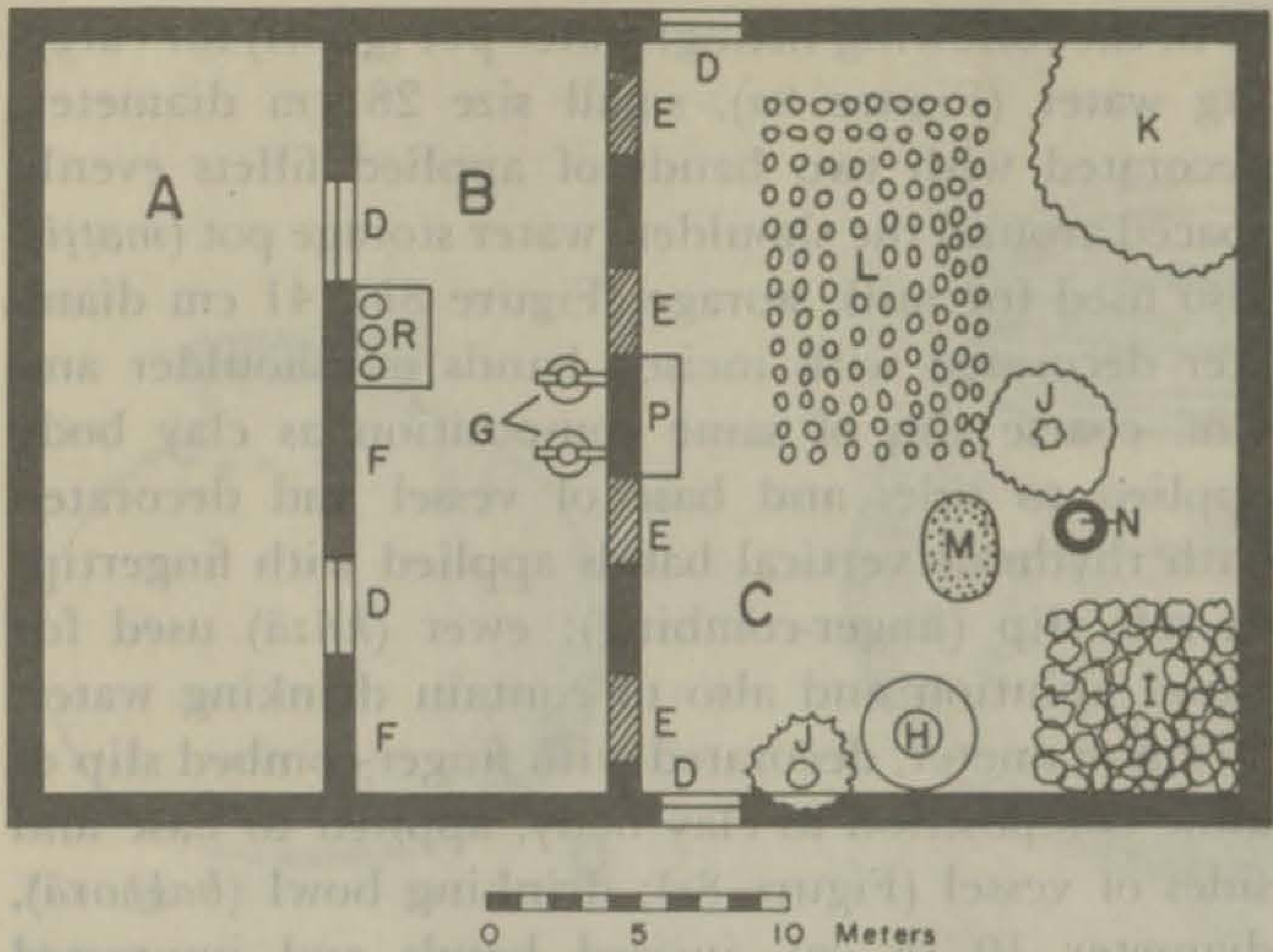


FIGURE 9.—Plan of workshop of potter Mir Shad of Shahbaz Ahmed Khel, NWFP. (A=living quarters, B=roofed workshop area, C=open courtyard, D=doorways, E=open archways leading into roofed workshop, F=shaded drying areas, G=pit wheels and tools, H=kiln, I=stacked bundles of reed fuel for kiln, J=shade trees, K=donkey's sleeping area and fodder, L=open drying area, M=clay preparation pit, N=clay storage pit, P=storage cupboard made from clay, R=food preparation area (O and Q not used to avoid visual confusion.) (See also Plate 31).

vessels from one area of the workshop to another. Although Mir Shad is 22 years old, much younger than most of the other Pakistani potters included in this study, he is considered by the other potters of the village to be a fully proficient craftsman.

He works all year round as a potter, with only slight seasonal variations in production. Work is interrupted when there is rain because vessels cannot be dried, and the kiln cannot be fired. Otherwise, he works six days per week producing the same range of vessels all year round. Most of his pottery is sold in the Bannu markets.

He learned the craft from his father, who was also a potter in the same village, and inherited his father's workshop. His workshop and house are combined under one roof (Figure 9). His land is a rectangular block 25 m wide and 40 m long, surrounded completely by a mud brick wall 4 m high. Another mud brick wall of the same height has been built across the land 10 m from one of the shorter walls. With two doors for access, this 10 by 25 m area encloses his house. A further wall, with four arched doorways, has been built across, parallel to the first; this wall encloses his workshop. The house and workshop have a common roof, constructed by first laying wooden beams across the tops of the walls, then constructing a layer of interlaced twigs across these, and then sealing the structure with mud. All walls and the roof periodically are replastered with mud and straw.

Because of *purdah* restrictions, the inside of the house was not seen, and the house has no windows or doors leading to the outside. The only access is via two doorways, one on either side of the open courtyard close to the outer wall of the workshop. The overall planning of the house and courtyard has been dictated by the requirements of defence. This area of Pakistan was one of the last areas of resistance against British incursions earlier this century, and villagers had also to contend with bandits and in some cases with other tribesmen with whom there were feuds. Although the necessity for such defensive structures has almost completely disappeared, the villagers still retain the style of architecture.

A plan of Mir Shad's workshop area is shown in Figure 9. All throwing and turning is done in the covered area of the workshop, and all drying and firing outside in the open courtyard. Two potter's wheels are located in the covered area of the workshop. These are pitwheels of conventional Northwest Frontier Province type, modified by replacement of the traditional iron point and stone cup lower bearing with a modern ball bearing from a truck axle. Dimensions of one wheel are: wheelhead, of *s̲h̲īs̲h̲am* (*Dalbergia sissoo*), 25 cm diameter; shaft, turned from *s̲h̲īs̲h̲am* wood, 5 cm diameter; flywheel, also from *s̲h̲īs̲h̲am* wood, diameter 62 cm, thickness 9 cm, weight 20 kg; wooden crossmember, length 1 m, 15 by 3 cm; distance from top of flywheel to top of wheelhead 73 cm; pit, excavated in the earth, unlined, diameter 75 cm average, depth 75 cm average.

MATERIALS GATHERING AND PREPARATION

Mir Shad digs his own clay from a deposit only 150 m from his workshop, on an area of common land. All other potters in the village use the same deposit. A pit has been excavated in the level ground to a depth of 2.5 m; the top 0.9 m of material is rejected as overburden, and the lower 1.6 m of material is used for pottery making (Plate 30). The overburden is leached soil, and the potter explained that it is not plastic enough to work on the wheel. The clay is dug as necessary, usually only enough material for three to four days work is dug at a time, because the clay deposit is so easily accessible. The clay is transported to the pottery by donkey; usually two donkey loads, totaling three maunds (about 135 kg) of clay, are dug and carried to the pottery at one time.

The clay is dumped into a clay preparation pit in the open courtyard near the potter's workshop. This pit is excavated in the ground to an oval shape, 2 by 1.8 by 0.5 m deep, with rounded sides. After continuous use for clay preparation the pit has acquired

a coating of clay which prevents any problems of contamination from the earth. Raw clay from the deposit is dumped directly into the pit and left to dry in the sun after larger lumps have been broken up. Waste clay from the pottery is also broken up and thrown into the pit for recycling. According to Mir Shad, a typical batch of body with three maunds of raw clay would have about half a maund of waste clay added (Plate 30*c*). When this material is dry, usually after 24 hours in the pit, and turned over once or twice, water is poured over the clay. Sufficient water is used to just wet the clay, but not to completely cover it. After the clay stands for two or three hours so that the water is thoroughly absorbed, it is kneaded by treading with the feet. When the clay is partially mixed by this process, sand is added by sprinkling it over the clay. The addition of sand is about three-to-one by volume of the dry clay; therefore, the body consists of about 75 percent clay and 25 percent sand by volume. The sand is prepared by sieving. The amount of sand added is determined by judgment rather than measurement so the exact amount varies from batch to batch.

At times, because of inclement weather or because the potter has commitments away from his workshop, it is necessary to store clay. For this purpose he has an underground pit, of truncated conical shape, 2 m deep and tapering from 0.6 m diameter at the top to 2 m diameter at the bottom. According to the potter, body stored in this pit and covered with wet sacks will keep moist "indefinitely." The pit is covered with a wooden lid.

Forming and Finishing Techniques

Mir Shad is unusual among unglazed-ware potters because he does not use the paddle and anvil technique at all. All of his pottery is thrown and turned. Since all the vessel types that he produces are relatively large, all pots are thrown individually on the wheel, in batches of 30 to 50. His normal practice is to throw this many pots in the morning, and turn all of that batch in the afternoon, as each dries to leather hard. This means careful control of drying so that vessels do not dry too much before they can be turned. Women of the potter's household are constantly involved in moving vessels from one location to another; out into the courtyard into the sun, back inside the workshop out of the sun, and they can judge accurately the moisture content of pottery vessels by the surface appearance and feel of the vessels.

The throwing of specific vessel types need not be described in detail, because the technique is similar for various vessel types. For any vessel type, the potter takes enough plastic body to form the pot, kneads it by hand, places the lump on the wheelhead, centers it, opens it with both thumbs, and throws the shape. For completeing the shape of large open-mouthed vessels he uses a profile tool on the inside of the vessel. This profile tool is a piece from the rim of a broken fired vessel. All shapes are thrown in one piece, only handles or spouts are added later. When throwing is completed the vessel is cut off with a cotton thread. One end is held in each hand and with the thread pulled taut it is pulled through the base of the vessel. The thread is placed back into a dish of water where it is normally kept and the vessel lifted from the wheel.

Vessels, such as the ewer and the water pot, are thrown from a lump of clay body placed directly on the wooden wheelhead. Other vessels, such as large bowls and dishes, are made by a different technique. First a coil of clay, about 5 cm in diameter, is formed, and placed around the perimeter of the wheel. It is pressed down so that it will remain in place. The potter then takes a batt, made from an unfired mixture of mud and straw. This is a flat disc 3 cm thick, of appropriate diameter to the vessel to be formed. The batt is placed on the coil of clay and centered, and then pressed down firmly so that it will function as a "wheelhead" without slipping. A lump of clay is then placed on this batt and the vessel formed. Then the batt is lifted off the wheel, and the thrown vessel with it, without distorting the shape of the thrown vessel. The use of this technique means that dishes and other shapes, which are normally difficult to lift from the wheel, can be thrown with relatively thin walls, which require the minimum of turning afterwards.

When the pots dry to leather hard they are turned, except the few vessel types that are completed at the throwing stage. The same type of turning tool is used for all vessel shapes. This is made from a piece of sheet steel 0.2 cm thick, 1.7 cm wide and 23 cm long, by bending one end, 3.5 cm long, at 90° to the rest of the strip. The longer end is the handle, the shorter end, sharpened on both sides, is the cutting blade.

Large dishes and vessels with wide flat rims are placed upside down for turning on a mud-and-straw batt on the wheelhead; the potter continuously kicks the flywheel with his right foot, that is, the wheel revolves counterclockwise, while turning. The turning tool is held in his right hand and his left hand maintains a steady pressure on the base of the pot to prevent it moving laterally.

The ewer (*kūzā*) shape, with handle and spout and only a narrow rim, requires a different turning tech-

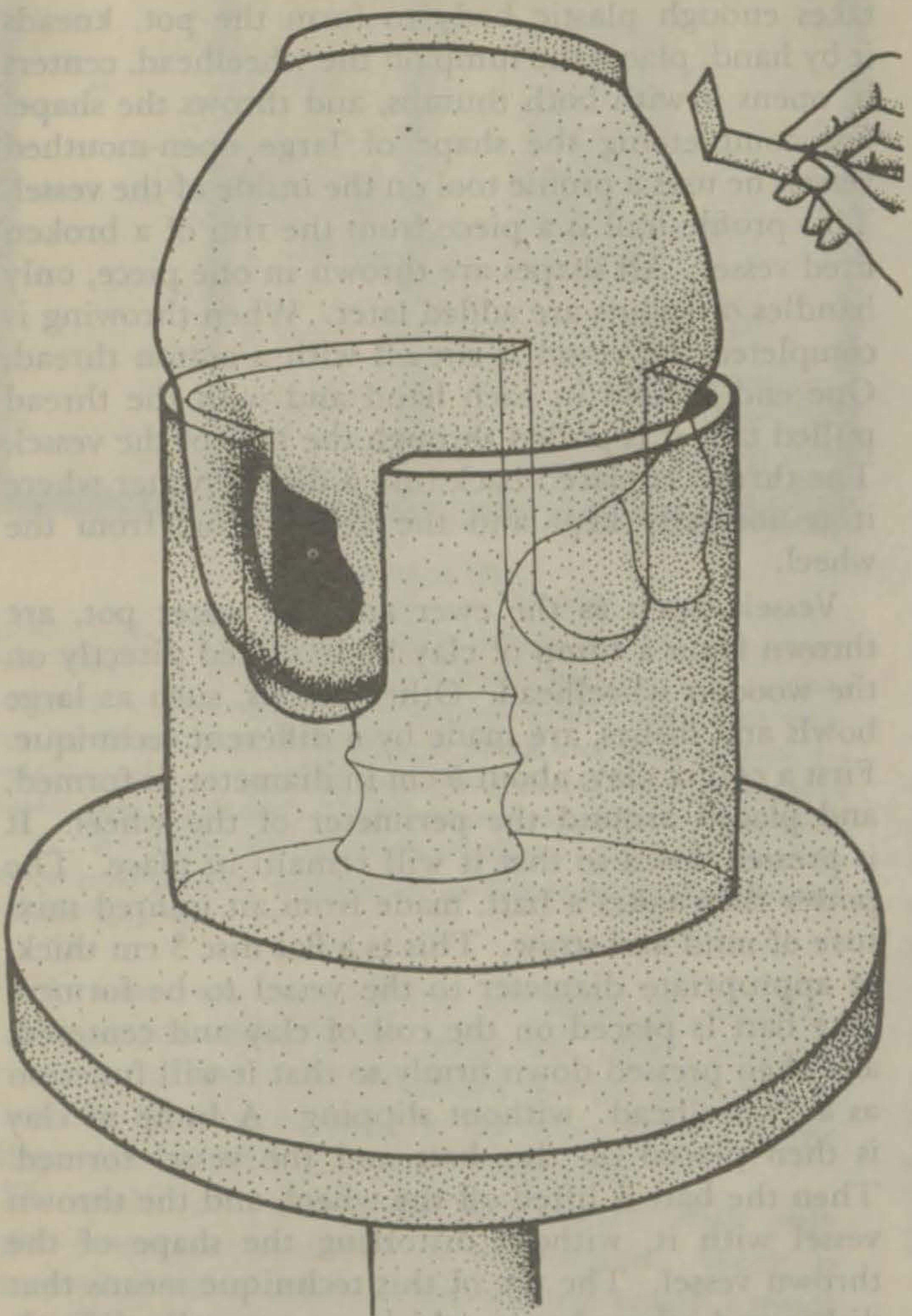


FIGURE 10.—Method of turning leather-hard ewer (*kūzā*) in chuck by potter Mir Shad of Shahbaz Ahmed Khel, NWFP. Shadow drawing shows how vessel fits in chuck on wheelhead.

nique. A biscuited chuck is used for this (Figure 10). The chuck, made from the normal pottery body, is made by first throwing a cylinder 20 cm diameter with thick walls. When this cylinder dries to leather hard, two U-shaped sections are cut from the upper walls, on opposite sides. The chuck is then dried and fired. In use it is placed on the wheelhead and centered, the U-shaped cutout sections uppermost. It is fixed to the wheelhead with some lumps of plastic clay. To burn a *kūzā*, it is placed upside down in the chuck so that the handle rests in one of the U-shaped sections and the spout in the other. Excess clay is trimmed from the lower sides of the *kūzā*, and a foot-ring forms on the base during the turning. After turning, all vessels are carried out into the sunlit courtyard by the women, and left there to dry completely.

Decoration

Some of the vessels of Mir Shad are decorated with impressed lines and bands while the vessel is still on the wheel after throwing. The water pot is decorated on the shoulder with a wavy band, applied with a pointed stick by pressing the point of the stick into the soft clay and moving it up and down quickly as the pot revolves on the wheel. A band, consisting of four closely spaced horizontal lines, is formed on either side of the wavy line to complete the decoration.

The ewer shape is also decorated with an impressed pattern while the pot is still on the wheel after throwing. The decoration in this case consists of a series of bands 0.3 cm wide, spaced 0.3 cm apart. Each band is made up of a series of vertical grooves, 1 mm wide and 1 mm apart. This decoration is applied with a small steel gear wheel held against the side of the vessel as it revolves on the wheel. The gear wheel is held on a piece of wire, passing through a hole in the center so that it revolves freely. Mir Shad could not say when this type of decoration originated, but it is probably recent, at least some time during the present century. It may have developed in the past from the use of a more traditional type of roulette tool of wood or fired clay.

Vessels that are decorated with impressed decoration are not further decorated afterwards. Other vessels are decorated with a black pigment or with a red slip and black pigment. Vessels used for storage of milk are decorated with black pigment only. This pigment is prepared by grinding a stone, which the potters themselves obtain from a deposit in North Waziristan, 40 km from Shahbaz Ahmed Khel, in tribal territory. The black stone is crushed with a hammer and then ground on a flat stone, using a quartz pebble for grinding. The fine black powder is mixed in water and applied with a brush, made by the potter from donkey mane. The brush is simply a bundle of donkey hairs, cut to 6 cm length and bound at one end with cotton thread. The bound end serves as the handle of the brush.

The water storage vessel is decorated with two bands, one a wavy horizontal band and another a repeated chevron pattern in a horizontal band; these two bands are bordered below and above with bands of five fine horizontal lines, the whole on the shoulder portion of the vessel. All decoration is applied with it revolving on the wheel.

Two types of dishes are decorated with both red slip and black pigment brushwork. The raw material for the red slip is obtained in the same locality as that for the black pigment. It is a brownish colored

clay. The slip is prepared by slaking the clay with sufficient water to form a thin slip. The clip is applied to smaller dishes by dipping, and to larger dishes by wiping the slip onto bone dry vessels with a cotton cloth.

Black pigment is then applied over the slip by brushing. Concentric bands or lines are applied with the dish revolving on the wheel. Checkered, wavy, or scalloped patterns are then applied freehand. Two typical decorations are shown in Plate 31*c,d*.

Firing

The kiln (Figure 11) used by Mir Shad is of unusual construction, unlike those seen in any other area in Pakistan. It is an updraft kiln, with the firebox directly below the setting chamber, the two separated by a floor with flame throats for passage of flame from the firebox up into the chamber. The most distinctive feature of the kiln is that the firebox is formed by excavating an underground cavity. First a small hole, 0.7 m in diameter and about 2 m deep, is dug. From the bottom of one side of this hole earth is gradually removed until the working space is large enough to enclose a man. Then by digging horizontally, a tunnel is formed at right angles to the original shaft. This tunnel is then extended into an oval-shaped underground room, approximately 2.5 m long, along the horizontal axis leading away from the original shaft, and 2 m wide. The exact dimensions of the underground structure could not be obtained because of the difficulty of access into the ash-filled firebox. The bottom of the firebox is 1.1 m below ground level, and 0.3 m of earth are left covering the top of the firebox. Buttresses of earth are left intact during the excavation to prevent collapse of the earth above the firebox; there are four of these, parallel to the short horizontal axis of the excavation, each about 0.25 m wide and semicircular in section.

When the firebox cavity is excavated, the original hole is partly refilled with earth so that the only access to the firebox is via a tunnel, angled at 45° to the vertical, leading to the top of the firebox. Then the chamber of the kiln is built above ground level, directly above and concentric with the firebox. The chamber is constructed from mud and straw and has cylindrical walls 0.6 m thick. When this simple structure is complete the flame throats, leading from firebox to chamber, are formed by piercing holes through the earth between firebox and chamber. There are 13 flame throats equally spaced around the perimeter of the chamber floor (each 10 cm in diameter), 8 more concentric with the former (equally spaced on a 1-m diameter circle, each 5 cm in diameter), and a single central throat (15 cm in diameter). A cutaway drawing of the final structure is shown in Figure 11. Dimensions are as follows: interior diameter of chamber, 2 m, height 2.6 m; exterior diameter of kiln above ground level, 3.2 m, stokehole diameter, 0.5 m.

When the kiln structure is completed initially, all surfaces are coated with a plaster of mud and chopped straw in a layer about 0.1 m thick. Mir Shad said that when the kiln is fired a number of times a coating of slag builds up in the firebox and flame throats, so that periodically this slag has to be removed and the surfaces again coated with the mud-and-straw plaster. This slag coating is formed by reaction of the fuel ash with the mud coating, a common phenomenon in kilns fired with vegetable fuels, such as wood. The fuel used by Mir Shad is reed-stems, gathered where the reeds grow wild in swampy areas near the village. Each firing consumes forty bundles of reeds, each bundle averaging 20 kg. The 2-m long bundles of reeds are sun dried in the potter's courtyard before use, usually over a period of at least one week.

The kiln is fired once every 10–14 days, the number of vessels and frequency of firing depending on the size of the vessels being fired. Dishes and bowls are stacked in vertical piles for firing; open-mouthed pots are stacked upside down, one upon another. *Kūzā* are set by first placing a layer of these vessels standing upright and as close together as possible; then setting another layer upside down, with the necks of the second layer fitting into interstices between vessels in the first layer, the shoulders of the second upside-down layer resting on the shoulders of the first layer. The third layer is then set upright, the footring of each resting on the foot of an upside-down vessel in the second layer. Subsequent layers repeat this alternating pattern until the setting is level with the rim of the chamber.

The top of the setting is then covered with a layer of sherds from vessels damaged in previous firings, placed so that they rest on the vessels and the rim of the kiln in an overlapping patterns. This layer of sherds is then covered with a plaster made of mud and chopped straw, 3 to 4 cm thick, in which many holes are left to allow flames and smoke to escape. The potter said that the total area of these flues is equal to the total area of flame inlet at the base of the chamber.

Firing is started by throwing a small bundle of burning reeds into the base of the firebox, and for half an hour maintaining a small fire by adding small bundles of reeds each time the fire burns down. The full fire is then begun. Bundles of reeds, each as large as can be held in the hand, are continuously fed through the stokehole into the firebox. The full

firing period lasts an average of eight hours. The finishing point is judged by the appearance of the flame emerging from the side of the chamber near the stokehole (Plate 30) and by the heat of the chamber wall at the outside. At the end of the firing, the fuel in the firebox is allowed to burn down and then the stokehole is closed with a slab made from mud and straw to prevent drafts of cold air through the kiln. The kiln is allowed to cool for at least 16 hours before any vessels are removed.

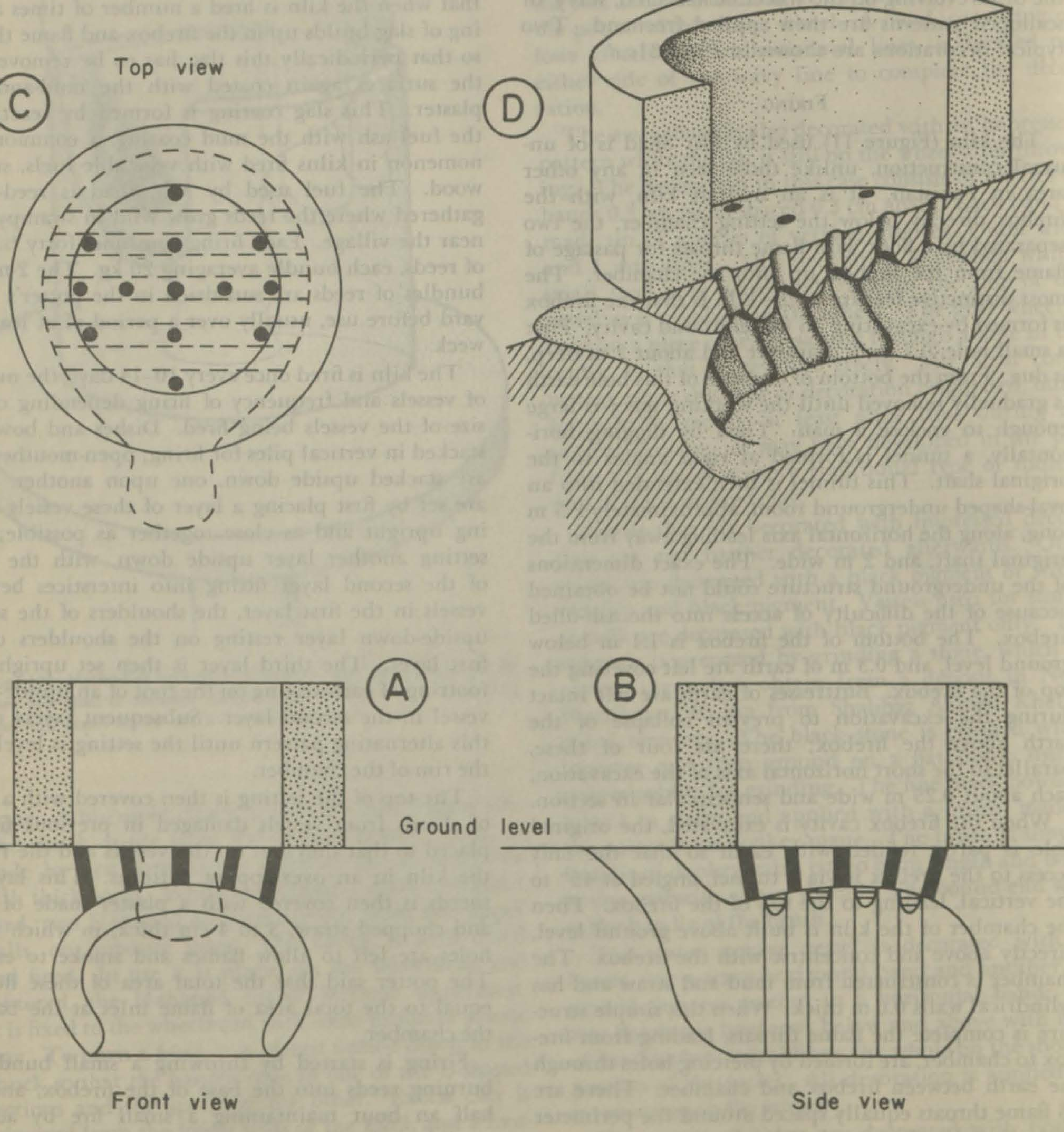


FIGURE 11.—Kiln of potter Mir Shad of Shahbaz Ahmed Khel, NWFP: *a*, sectioned front view (looking toward stokehole); *b*, sectioned side view; *c*, top view (firebox indicated by broken lines); *d*, sectioned perspective drawing. Outside diameter of chamber walls 3.2 m.

TABLE 1.—*Vessels produced by potter Mir Shad, Shahbaz Ahmed Khel, NWFP*

GROUP	TYPE	SIZE (cm)		PRODUCTION	SALE PRICE	
		Ht.	Dia.	No.per day	No.	Rupee
1	Bowl with solid foot	11	23	100	12	1.00
	Small bowl with solid foot	5	10	500	50	1.00
2	Water vessel with handles	25	27	80	6	1.00
	Water pitcher with handle and spout	28	19	80	6	1.00
3	Milk vessel with lid	22	24	80	6	1.00
4	Large dish for serving food	-	38	40	1	0.60
	Three large dishes for kneading bread dough	- - -	33 43 54	40 40 40	1 1 1	0.60 0.60 0.60

TYPES OF POTTERY

The vessels produced by Mir Shad are divided into four groups, on the basis of finish and decoration: First, those vessels that are thrown but not turned or decorated; second, the group that is thrown and turned, and decorated with incised or impressed patterns; third, the group that is thrown and turned and decorated with black pigment brushwork; and fourth, the group that is thrown and turned, and decorated with a coating of red slip and black pigment brushwork over the slip. Table 1 gives data on the vessel types in each group, the sizes of vessels, the rate of production of these vessels in one working day, and the sale price for each vessel type.

The data for rate of production of the different vessel types apply only to the situation where the poter has clay already prepared and works continuously through a day, throwing and turning vessels, and decorating. These figures were given by the potter as representing maximum production under such conditions. Such production cannot be continuously maintained because the potter has to spend time on other tasks such as digging clay, preparing body, firing, selling, and maintenance.

Comparison of the rate of production data with the sale price data suggest that some types of vessels are more profitable to produce than others. According to the potter this is not true in practice because of other variables, such as the amount of body used for each type and the resultant variations in time and labor expended in body preparation. Market demands for specific vessel types also cause variations in the profitability of production of each vessel type. The potter summarized by saying that there is no economic incentive to continuously produce one vessel type in favor of another. From the viewpoint of satisfaction from his work, he personally enjoys making *kūzā* more than any other vessel.

Village of Nurar

Pottery making was observed in this village by Godden (1969 unpublished field notes). The population of the village was estimated at 1000 families, 11 of them potters. These potters sell the majority of their wares in the pottery bazaar in Bannu city.

The techniques of pottery making are not described in detail as they are not markedly distinct from those described in other parts of this work. Usually, the vessel types differ from those made by Mir Shad, except where vessels with similar functions dictate similar forms. The decorative technique, however, is different. The Nurar potters use a white-cream slip on some vessels, in contrast to the more common red-slipped ware of the Bannu district.

TYPES OF POTTERY

Water carrying vessels in Nurar, used for storing and carrying water, have lugs to enable their attachment to a camel-saddle, and a foot upon which the vessels can be placed upright on the ground (Plate 32*d,e*). They are made in various sizes. Two are in the Smithsonian Institution collection: USNM 412,-568 is 25 cm in diameter, 30 cm long, and 18 cm high, standing on the foot. USNM 412,569 has corresponding dimensions of 20 cm diameter, 23 cm long, and 15 cm high. Larger sizes are also made. These vessels are thrown, turned, and joined. Cream slip of white, sandy clay is applied by pouring the slip over bone dry vessels. Ewer with a handle and spout (*kūzā*) is made for ritual and other ablutions, undecorated. A similar vessel without a handle has incised decorative bands on neck and is 28 cm high. The water storage pot with lid is round-bottomed and cream slipped with agraffito decoration in incised lines exposing the red body underneath. The churn for churning curd is cream colored with sandy slip applied and decorated by forming swirling patterns with the fingers while the slip is still fluid: diameter 45 cm. The small milking pot is undecorated, with lid; diameter 11 cm.

The rice husking mill (Plate 32*a,b,c;* USNM 412,570), diameter 34 cm with height to top of handle 20 cm, is made by handmolding and decorated with wavy concentric bands applied to soft clay with fingertips, and a band of finger-indentations around the perimeter. The lower or grinding surface has diamond-shaped indentations, made with a diamond-

pointed, biscuited clay tool; these indentations cause the grinding in use. The top surface has bands of red slip applied in radial and concentric patterns. The mill is used as follows: a flat-topped stone, usually from a stone mill, is set in the ground. A wooden plug is driven into a hole in the center of the stone; the wood surface is flush with the stone surface. An iron spike is driven into the wooden plug. This iron spike acts as the axle of the mill. With the mill top in place, the ceramic grinding wheel is turned with one hand and grain fed into the central hole in the top of the mill with the other. Rice is recovered by lifting the ceramic top from the mill and sweeping the grains into a container.

DERA ISMAIL KHAN, NORTHWEST FRONTIER PROVINCE

Dera Ismail Khan is one of a series of important centers west of the Indus River, in the Northwest Frontier Province. Traveling southwards these are Kohat, Bannu, Dera Ismail Khan, and Dera Ghazi Khan. In Kohat and Bannu most of the pottery production is in surrounding villages, and the potters bring their wares in to a central market for sale and distribution. In Dera Ismail Khan the main pottery production is within the boundaries of the city itself, in a potter's village on the outskirts. This area is known as Kumbaran Wana Mahalla. An exact figure could not be obtained but it is estimated that between 10 and 15 separate workshops are operating in this area. In some cases a family of potters has their workshop enclosed by the same courtyard as their living quarters, and in a few cases the potters have a separate specialized workshop. Apart from a range of vessels for domestic use, potters in this area are also producing *tanur* and tiles, primarily perforated tiles for use in screen walls.

Pottery making was observed in the workshop jointly operated by three potters. Mahommed Jan, Ghulam Hassan, and Mahommed Sharif. The first two mentioned are brothers, with whom Mahommed Sharif is a business partner. Their work area is spread over three different localities. The main work area is in a courtyard adjoining the house in which the two brothers and their families live. One end of the courtyard is covered with an awning under which potter's wheels *(dukān)* are located. Across the street from the entrance gate to this courtyard is another open courtyard, also with an awning in one corner. Under this awning another potter's wheel is located. Animals owned by the two brothers are kept in this courtyard, which is mainly used as a storage area. Clay, feed for the donkeys, and fuel for the kiln are kept there, as well as a stockpile of fired pots for sale. A third area is also part of the pottery; this area is open, with no surrounding wall and thus accessible to the roadway passing nearby. The kiln is located on this open area.

The potters *(kumhār)*, who learn their craft from their fathers, beginning at an early age, and said that the types of ware they are producing, and the methods used for making them, have not changed in their lifetime.

Materials Gathering and Preparation

The clay body used in this workshop is clay *(miṭṭī)* used without admixture. The exact source of the clay is not determined. Three donkey loads, approximately six maunds or 270 kg of clay are brought to the pottery every three working days during the working season of eight months per year. This amount of clay is used by the three potters over three working days. As the clay is brought into the main working courtyard it is dumped from the donkey bags onto the ground and spread in a layer about 15 cm deep. This allows the slightly moist clay to dry (*sukhānā*, "to dry," *Sūkhā*, "dry") in the sun. When the larger lumps of clay dry they are broken up (*miṭṭī kuṭāṇī*, "to break the clay") with a stick (*munglī*) until all lumps are reduced to a diameter of 1 to 2 cm or smaller.

The clay is then placed in a pit (*ṭoyā*) in one corner of the courtyard. This pit is dug so that two of its sides are downward continuations of the courtyard walls, and the remaining wall of the pit is rounded. The pit is 0.8 m deep, and each of the straight sides is 1 m long. Through use the walls and base of the pit have built up a coating of clay, so that there is little chance of the clay becoming contaminated with earth from the walls of the pit. The pit is filled to within about 10 cm from the top with clay, and then water is poured in (*miṭṭī pusāṇī*, "to wet the clay") until there is sufficient moisture to wet the clay to the correct degree of plasticity. The clay is then left to soak until it is required for use. One of the potters kneads the clay with his feet (*latārī*, literally "trampling") by actually standing in the pit and working the clay to an even moisture content. As the clay at the top is mixed to the proper plasticity,

it is removed, exposing more unmixed clay which is then kneaded in the same way. This process of kneading and removal is continued until all the clay in the pit has been so treated. The kneaded clay not required for immediate use is stored in the covered area of the workshop and kept moist by covering it with wet hessian sacks. More water is sprinkled on these sacks as required to keep the clay moist (*kūlā*, "plastic clay").

Forming and Finishing Techniques

The main product of this pottery is water jars (*ghaṛā*). These are made in two sizes, the smaller, 35 cm in diameter, for carrying water and the larger, 73 cm in diameter (Plate 33), for permanent water storage in the home. The vessels are formed by a combination of throwing on the potter's wheel and finishing with paddle and anvil.

The first stage is hand-kneading (*lisāvan*) the clay. A bench is used for kneading; this bench (*pinne-vaṭ*) is a disc of fired clay, 0.6 m in diameter, placed on the ground. The kneading of a lump (*ḍobā*) of clay begins with rolling the lump into a cylindrical form. With the cylinder placed on the bench transverse to the potter's body, he uses the heels of his hands to push the center of the cylinder away from his body and at the same time flatten it (Plate 33). The clay is then rolled to reform the cylinder. After repeating this three or four times the potter again flattens the cylinder in the same way and twists off the two ears, or ends of the cylinder, one with each hand. He thumps these two smaller lumps together in his hands to form one lump, which he then raises above his head and slaps down onto the larger lump. The mass is rolled again to form a cylinder and the whole cycle repeated until the clay reaches an even consistency.

The initial form of the water jar is thrown on the potter's wheel. The wheels are of the pit-wheel (*ṭoyā*, "pit") type. A wheel from Dera Ismail Khan is in the Smithsonian Institution's Department of Anthropology collection, USNM 417,237. In the initial throwing a lump of clay is placed directly on the wheelhead (*ṭopaī*) and a vessel with thick walls at the base is thrown. The neck (*galā*) and rim of the pot are completed on the wheel, leaving only the base (*tālā*) to be modified by use of the paddle and anvil.

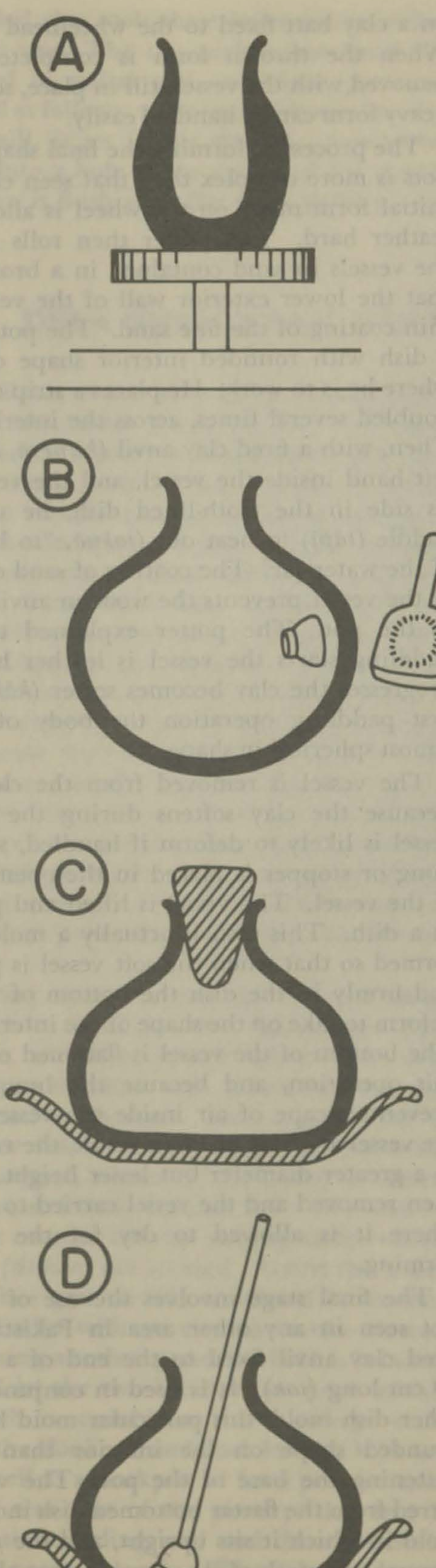
After cutting off with a thread, the initial form is removed from the wheel and placed aside to dry to leather hard (*vatar*).

The large water jars are given their initial form in the same way. The work starts with a lump of clay weighing 40 to 45 kg. The lump of clay is placed on a clay batt fixed to the wheelhead with soft clay. When the thrown form is completed, the batt is removed with the vessel still in place, so that the large heavy form can be handled easily.

The process of forming the final shape of the water pots is more complex than that seen elsewhere: The initial form made on the wheel is allowed to dry to leather hard. The potter then rolls the outside of the vessels in sand contained in a broad flat dish, so that the lower exterior wall of the vessel takes on a thin coating of the fine sand. The potter then places a dish with rounded interior shape on the ground where he is to work. He places a strip of cotton cloth, doubled several times, across the interior of the dish. Then, with a fired clay anvil (*kunerā, kunairā*) in his left hand inside the vessel, and the vessel resting on its side in the cloth-lined dish, he uses a wooden paddle (*tāpī*) to beat out (*ṭoknā*, "to beat") the base of the water jar. The coating of sand on the exterior of the vessel prevents the wooden anvil from sticking to the pot. The potter explained that when the paddling starts the vessel is leather hard, but as it progresses the clay becomes softer (*kākā*). After this first paddling operation the body of the vessel is almost spherical in shape.

The vessel is removed from the cloth-lined dish. Because the clay softens during the paddling, the vessel is likely to deform if handled, so a temporary bung or stopper is placed in the opening at the top of the vessel. The vessel is lifted and placed upright in a dish. This dish is actually a mold, the interior formed so that when the soft vessel is placed quickly and firmly in the dish the bottom of the vessel will deform to take on the shape of the interior of the dish. The bottom of the vessel is flattened considerably in this operation, and because the bung in the neck prevents escape of air inside the vessel, the sides of the vessel are bulged. As a result, the vessel is formed to a greater diameter but lesser height. The bung is then removed and the vessel carried to a drying area, where it is allowed to dry for the final stage of forming.

The final stage involves the use of a tool that is not seen in any other area in Pakistan. This is a fired clay anvil fixed to the end of a wooden stick 50 cm long (*ṭok*). It is used in conjunction with another dish mold, this particular mold having a more rounded shape on the interior than the one for flattening the base of the pot. The vessel is transferred from the flatter bottomed dish mold to the final mold in which it sits upright, and the *ṭok* is inserted through the neck of the vessel so that the bottom can be beaten (*ṭokna*, "to beat with *ṭok*") from the inside to the final profile given by the dish mold. When



this final forming is completed the water jar is removed from the mold and placed upside down in the courtyard of the workshop for drying.

The various stages of the forming process (Figure 12) are divided among the three potters in the workshop in order to achieve efficiency of production. The throwing operation is relatively fast compared to the second stage of beating out the base of the pot with a paddle and anvil. The third forming stage, finishing the base in a mold with a long-handled anvil, is also faster than the intermediate paddle and anvil forming. The drying between operations is a slower process than the forming operations themselves. Thus, the work is organized to an optimum batch of vessels, which provides continuous work for the three potters.

The cycle of work may be outlined as follows: One of the potters breaks up the lumps of raw clay and spreads them out for drying while the second one throws a batch of 40 to 80 vessels on the wheel. During this time the third potter completes the various batches of vessels by beating the bases to their final shape in dish molds. The second potter either carries the vessels out into the courtyard for drying to leather hard, or has an assistant, usually the children of one of the potters, carry them out for him.

On the second day two of the potters start to beat out the bases of the batch of vessels that were thrown on the previous day. In this second forming stage, the paddle and anvil are used. This work occupies one of the potters for the full day. One of the two alternates between this operation and the third operation, which completes the base of the vessel in a dish mold, using the long handled anvil to beat the shape to the mold form.

The third potter takes the clay that was spread out in the sun the previous day, places it in the clay preparation pit, and adds water. He throws a further batch of 40 to 80 initial forms on the wheel. These are carried out to the drying area. The third potter also takes a previous batch of vessels which had been through all the forming operations and are now completely dried, and applies a slip to them. They are again placed in the drying area for the final drying before stacking to await firing.

On the third day of the cycle, the second forming stage again occupies one of the potters for most of the day and another for part of the day. Another

FIGURE 12.—Stages in forming a water pot, Dera Ismail Khan, NWFP: *a*, original shape thrown on wheel; *b*, walls thinned with beater and anvil; *c*, base flattened in mold; *d*, after further drying, final shape completed by beating pot into mold with long-handled anvil.

potter kneads a new batch of clay in the soaking pit by treading it with his feet, and then removes the clay and carries it into the covered area of the workshop where it is stored for use. He throws another batch of 40 to 80 preliminary shapes and carries these out for drying. Another of the potters completes the third forming stage (beating out the base of vessels in a dish-mold) on the vessels that received the second stage on the previous day. One of the two potters, not working with the paddle and anvil, applies slip to complete and dried vessels, and stacks them ready for firing.

This brief outline of a three-day work cycle is somewhat generalized and requires further explanation. The three potters in this workshop are each skilled in all aspects of the craft and can replace one another in the various operations when required, although one man does most of the throwing and another is normally responsible for completing the third forming stage of the water pots. The cycle outlined above is based primarily on the time restrictions imposed by the drying of vessels, so that it is usual for vessels thrown on one day to be refined with the paddle and anvil on the next. Variations are introduced according to whether vessels are thrown or formed with the paddle and anvil in the morning or in the afternoon. The second drying stage, between use of the paddle and anvil and the long-handled anvil and dish mold, is another time variable dependent on drying conditions and the time of the day the drying is started.

The cycle is also varied when the potters undertake other tasks, such as obtaining clay, making slip, workshop maintenance and, particularly, preparation for firing. The firing occupies all the potters and interrupts the normal work cycle with the tasks of setting the pottery, removing it after firing, and storage or distribution of the finished vessels. The cycle also varies when pottery other than water jars is being made. The workshop produces some perforated tiles and dishes. The large water jars require more work than the smaller ones, and this also affects the rate at which smaller water jars are produced. So the cycle given above shows a possible sequence of work in the pottery which varies according to the demands of the market and the work. In practice, the potters said that they can produce 1000 water jars per month, but usually the production is much less than this, particularly when other types of pottery are being produced. The average production rate is estimated at 300–400 vessels a month.

Decoration

The only forms of decoration for pottery produced in this workshop are slip applied to the exterior of water jars, and pigment brushwork on dishes. The slip is very coarse in texture on the finished vessels. It is composed of clay, two parts by volume; sand, one part by volume; and salt, two parts by volume.

The clay is the same as that used for making vessels. The slip is prepared by sieving the clay through a sieve with apertures of approximately 1 mm. The sand is obtained from sand-drifts near the potter's village, and the salt is common salt (primarily NaCl), obtained in block form at the bazaar. The three materials are mixed with water to a thick consistency in a large earthenware vessel.

The slip is applied (*le deṇā*) at the thick consistency by scooping a handful of slip from a vessel and rubbing it around the exterior wall of the water jars. Broad rhythmic patterns (*dingrā*—"crooked") are formed in the thick coating by dragging the tips of the wet fingers through the freshly applied and still wet slip. The slip is applied to vessels only after they are completely dry. The potters said that the slip is partly applied because of its decorative value but that the major reason for using the slip is "to keep the water colder." The coarse texture of the slip increases the surface area from which water permeating through the porous walls of the vessel could evaporate, so it is reasonable to say that the faster rate of evaporation indeed produces cooler water. No measurements of temperatures of water in slipped and unslipped vessels are available.

The pigment used for decorating dishes is obtained from an unspecified locality "in the hills near Dera Ismail Khan." Examination of a sample of the pigment material (*kālī garī*) shows that the primary colorants are iron and manganese. This accounts for the black color of the fired pigment. The raw material is a black stone, prepared by crushing (*kuṭṭṇā*, "to crush") in a mortar and pestle and then grinding (*malaunā*, "to grind") to a fine particle size. It is mixed with water to a dilution suitable for brushing and applied to vessels with a brush (*citraṇ*) made from horse or donkey mane.

The potters said that they use a red slip (*khākā*) on some vessels, and provided a sample of a red-brown mudstone (*lāl garī*) which they said is mixed with water for use as a slip. This material was not being applied to any vessels produced at the pottery workshop during the time of this study.

Firing

The kiln used by the potters is closely related to Panjabi *āvī*. It is situated in an open area of ground near to, but outside the walls of, the potters' workshop. The kilns of several other workshops are located in the same area, and are of similar structure to that described here.

Although the kiln is of a relatively simple type, its structure and setting are complex. The kiln is built on slightly sloping earth, the slope being about one in ten. On this, four mud walls are built, each wall averaging 1 m in height and 0.5 in thickness (Plate 34*b*). Broken vessels (placed upside down) and sherds are used as fillers in the construction of these walls. The front and back walls are approximately 6 m in length and the side walls 20 m long. These walls are not in contact with fire during firing, but are primarily to protect the setting that is built up within them.

Behind the front wall is a permanent firemouth (*morī*) (Plate 34*a*). A hole of about 1 m^2 in dimensions is behind the front wall of the kiln and a low wall of mud is above the back of this hole. A tunnel through the base of the excavation leads back to the base of the setting area. This tunnel about 0.3 m in diameter, supplies air to the lower front of the setting.

The floor (*ḍaggar*) of the kiln is simply the sloping earth contained within the outer walls described above. The setting is built up on this floor each time the kiln is fired. First a layer of sugar cane fronds (*paṭrā*) are placed on the floor. This first layer is about 0.6 m deep. Within the outer wall, a low wall of loose earth, about 15 m long at the sides and 5 m long at the back contains this fuel. On top of the layer of sugar cane fronds a layer of dung fuel is placed to a depth of 0.3 m. Then a layer of small bowls is set on top of the dung. This thin layer of pots contains many reject pieces from previous firings, and acts as a foundation upon which the larger vessels are set. The fourth layer comprises the main setting of pots, primarily water jars, which are set upside down in a number of layers. The setting contains approximately 600 vessels, not including the lids for water jars, which are set in a further layer on top of the water jars. If large water jars are included in a firing, they are placed at the bottom of the setting so that their weight does not damage other vessels.

A layer of dung fuel, about 0.3 m deep is placed above the vessels. The dung is mixed with earth, which helps to provide an insulating layer above the vessels. A wall of cracked or damaged vessels is built up around the sides of these upper layers. This wall provides draught for air passing through the firemouth, and through the layers of fuel and the vessels being fired. If, during the firing, part of the earthen cover over the setting collapses, the hole is covered with sherds and earth to prevent strong draught through the top of the setting.

In some firings further fuel is added during the firing. This is necessary when the dung fuel is of very poor quality, with extensive amounts of earth and dust admixed. The added fuel is wood, the potters using any type that is available and low-priced. The pieces of wood are fed in between the pots through openings between the damaged vessels used to form the upper "walls" of the kiln. The amount of wood used in a firing depends on the quality of the dung fuel, varying between two and five maunds (72–180 kg). The potters could not give the weight of other fuels used, but the volume of sugar cane fronds is about 10 m^3 and of dung fuel about 8 m^3.

The time taken for one firing, from beginning the fire to the initial removal of the vessels, is 48 hours. The potters fire the kiln four times a year.

The results are said to be best in summer, with the lowest firing losses. It is not possible to obtain an accurate estimate of typical firing losses, but the potters said that up to one-third of the setting may be damaged in firing.

SHAHDARAH, PANJAB

The small village of Shahdarah is on the outskirts of Lahore, near the river Ravi and near to the Moghul building group that includes Jahangir's tomb. Several workshops in the village produce unglazed earthenware, which is used locally and also sold to bazaar-keepers in other villages in the vicinity. The workshop of Mahommed Husain was visited in 1971. Due to time limitations full observations could not be made so the following account is brief.

Two potters (*kumhār*) are working full time in the workshop. The workshop itself consists of a covered area where potter's wheels are situated and an open area sheltered from the nearby roadway by trees. The kiln occupies most of the open area, which is also used for placing vessels in the sun for drying. At the back of the open area, away from the road, one of the potters has his house, and children play among the vessels in the open area.

Forming and Finishing Techniques

Methods of obtaining and preparing the clay body were not studied. The potter's wheel, a pit-type wheel with a brick-lined pit, is used to shape the initial form of all vessels. Three variations in forming technique are used: (1) The first completes vessels by throwing on the potter's wheel. Vessels formed in this way are flowerpots (*gamlā*), in various sizes up to 30 cm in height; large dishes (*kunālā*) for preparing *capaṭī*, the bread of Pakistan. The *kunālā* are 33 cm in diameter; money boxes for saving coins (*gallā*), 15 cm in height; and drinking pots (*bakhorā*, from *āb-k̲h̲orā*), 11 cm in height. (2) Two types of water storage pot (*chattī* and *maṭkā*), respectively 35 cm and 41 cm in diameter, are thrown, partially dried and then completed by expanding the form of the base using a paddle and anvil. (3) Other products are thrown and turned to final shapes. These are *dhaurā*, the lid for the *chattī*, *piālā* (11 cm diameter), a small bowl used for drinking; *ḍhakkan*, another type of lid for the water pots, *loṭa*, 20 cm high, a water pitcher with spout formed separately by throwing and then joining to the body of the vessel; and *topī* the tobacco bowl for a hookah.

The vessels which are made by the second forming techniques are almost identical to those used at Dera Ismail Khan (page 50). The clay is kneaded by hand before use, in the same way as at Dera Ismail Khan. The initial form of the vessels is thrown from a lump of clay placed directly on the wheelhead, without using any form of batt or mold. After allowing the thick walled form to dry to soft leather-hard condition the potter completes the base by beating it with a wooden paddle and thrown-and-fired clay anvil. The turning technique used on some other vessels was not observed.

Decoration

The *cilam* is decorated by incising a series of straight and wavy bands into the clay with a pointed wooden tool, while the freshly thrown vessel is still on the wheelhead.

All products of the workshop are coated with a red-firing slip, after they are completely dried. The slip is made from a yellow ochreous clay, which the potters said is obtained commercially from Gujrat. This yellow clay (*pīlī miṭṭī*) also is used in other workshops in the Panjab. It is bought in the form of a powder and prepared for use by placing it in a large dish, adding sufficient water to form a thin slip, and stirring it to an even consistency with the hands. The slip is applied to smaller vessels by dipping the vessel into the slip. It is applied to larger vessels by a combination of dipping and pouring the slip over the vessels. The slip is scooped up in one hand, holding the vessel over the slip dish so that excess slip runs back into the dish.

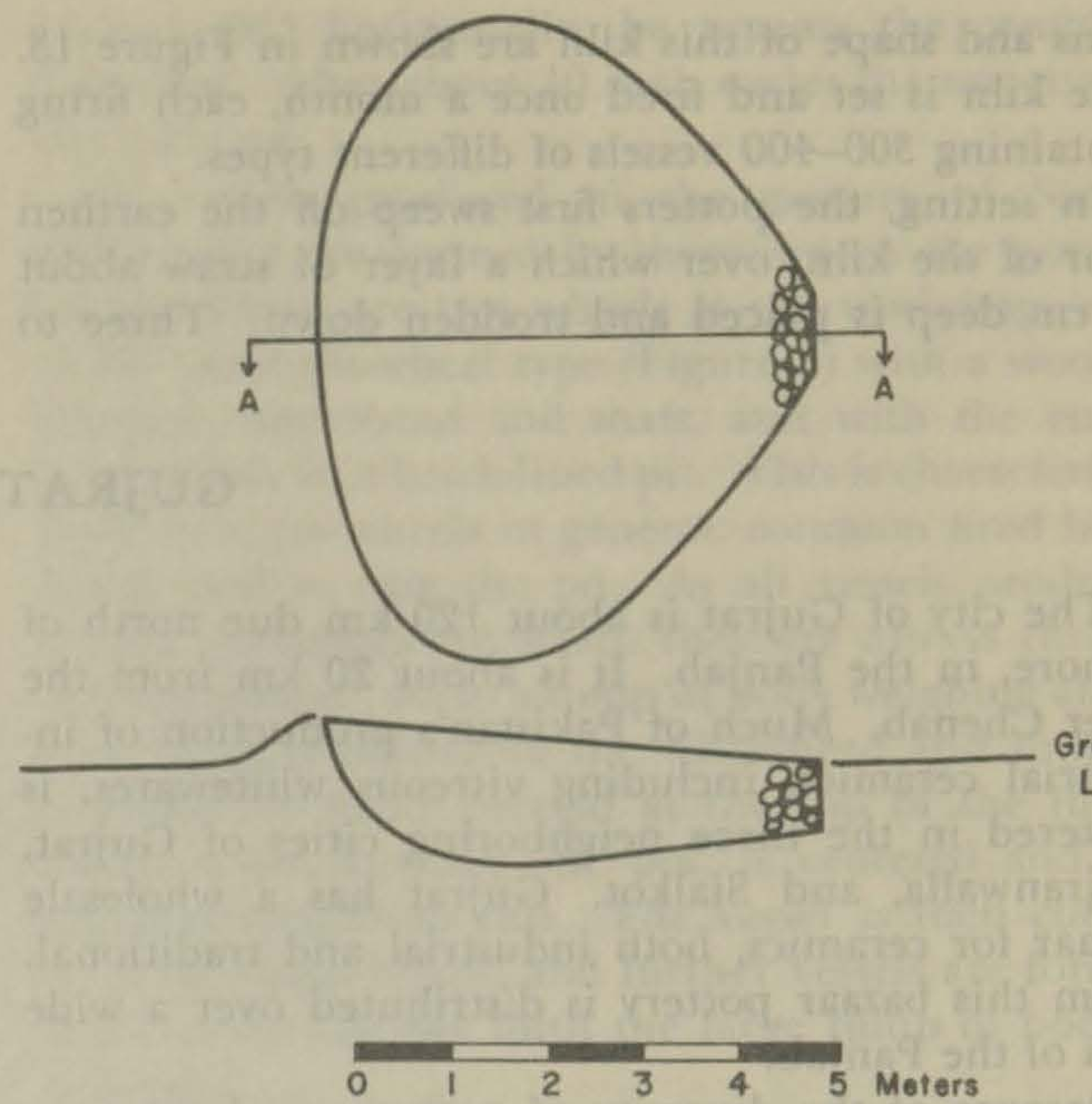


FIGURE 13.—Open pit-kiln (*āvī*), Shahdarah, Panjab: *top*, plan view; *below*, cross-section A–A.

The large water in jars are also decorated with pigment brushwork after the slip is completely dry. The black pigment material is ground very finely and suspended in water for application. The brush used for this work is made from donkey mane, twisted into a bundle and tied around at one end with fine thread. The process of applying the pigment is different than that seen anywhere else. The potter first places on the ground a flat piece of sheet metal, upon which he rests a round wooden cup, slightly pointed at the base and hollow at the top. He rests the base of a large water jar in the hollow top of the cup. A lid with a pointed knob is placed on top of the water pot. Then, with one finger of his left hand resting on the point of the knob on the lid, he spins the vessel with the other hand so that the complete assembly revolves on the pointed end of the wooden cup. As the vessel revolves he applies straight and wavy bands to it with the brush held in his free, right hand.

Firing

The kiln, said by the potter to be a *bhaṭṭī* (a term normally reserved for updraft, enclosed chamber kilns), is a pit of the Panjab *āvī* type. The dimen-

sions and shape of this kiln are shown in Figure 13. The kiln is set and fired once a month, each firing containing 300–400 vessels of different types.

In setting, the potters first sweep off the earthen floor of the kiln, over which a layer of straw about 15 cm deep is placed and trodden down. Three to four maunds of straw are used. A layer of dung is placed over the straw, the pots are set in a layer over the dung, and finally another layer of dung fuel is placed over and between the pots. Each setting uses about twenty maunds of dung. Further firing data was not obtained.

GUJRAT, PANJAB

The city of Gujrat is about 120 km due north of Lahore, in the Panjab. It is about 20 km from the river Chenab. Much of Pakistan's production of industrial ceramics, including vitreous whitewares, is centered in the three neighboring cities of Gujrat, Gujranwalla, and Sialkot. Gujrat has a wholesale bazaar for ceramics, both industrial and traditional. From this bazaar pottery is distributed over a wide area of the Panjab.

Because of the diversity of pottery production in the area, it was necessary in Gujrat to be selective in deciding which potters to interview and observe in their workshops. After a brief survey, representative of three groups were singled out for study: a traditional potter specializing in the production of *ṭopī*, a semitraditional pottery producing lead-glazed white earthenware bowls; and potters in the village of Shahdiwal, near Gujrat, producing decorated unglazed red earthenware dishes called *kunālī*. The brief initial survey showed that the number of potters in the Gujrat area is very great, in the order of thousands (an exact census could not be obtained). It also showed that many of the potters, probably a majority, are highly specialized and not only produce just one class of ware (glazed, unglazed, etc.) but usually only produce one or two types of vessels, such as, bowls, waterpots, dishes. This leads to a more highly organized production and distribution structure than is seen in any other area in Pakistan, with stricter division of labor. Thus, it is common to find that a single pottery had throwers, turners, kiln men, and other specialized workmen rather than a number of potters, each of whom were competent in all aspects of the craft. The distribution of finished products is also divided into specialized roles: buyers, porters, bazaar-keepers, and others. A study of the division of labor and organizational structure was not possible in the time available.

As at Multan, the Gujrat potters begin working in potteries as apprentices at an early age and become specialized in one aspect of the craft. Some continue to become master potters, skilled in all aspects of the craft. Master potters usually are the sons of master potters. Apart from having the skill to perform all aspects of the pottery craft, they are also expected to be able to transmit their skill to others by teaching; and they are also expected to know the history and legends of their craft. Rye was fortunate to have the assistance of a master potter, Ahmed Din, in the selection of specific potteries for study and in establishing rapport with the potters.

Garhi Maqbulabad

Almost all of the traditional red earthenware pottery production in Gujrat is centered in the area known as Garhi Maqbulabad. Many of the white, lead-glazed, earthenware products are also produced in this area, although this type of ware is made in factories distributed around the city of Gujrat.

The main product of the pottery operated by Sardar Mahommed is *ṭopī* (Plate 35*a*), the bowls for the traditional hookah. The hookah is used all over Pakistan and is made in a great variety of forms. Apart from pottery versions, it is also made in other materials, such as, metal or wood. The common type in Gujrat is a ceramic of unglazed red earthenware or metal body to contain water, and a red earthenware bowl (the *ṭopī*) to contain tobacco.

The pottery operates continuously throughout the year. Sardar Mahommed shares the work with his brother; both are *kumhār*, the Panjabi term for red earthenware potters. There is no strict division of labor between the two, and both are proficient in all aspects of the workshop production, but Sardar Mahommed usually sets the kiln because he likes that task, while his brother prefers to continue throwing and turning during the kiln setting and firing. Sardar Mahommed, as the elder brother, is usually responsible for the sorting of fired vessels and the sales to shopkeepers.

Materials Gathering and Preparation

At this pottery the potters usually dig their own clay, although it is common in Gujrat for potters to buy clay from suppliers. The raw clay (*gīlā*, "moist";

miṭṭī, "clay") is kept in a stockpile in the potter's courtyard, so that it can be sun-dried before preparation (*sukānā*, "drying"). When the clay is dry (*sukkī*, feminine form, *sukkā*, masculine) it is broken (*toṛnā*, "to break up") into small lumps (*dhẽmh*). The clay is then sieved (*chāṇnā*, "to sieve") with a wire mesh sieve having apertures of about 0.6 cm. These sieves are the modern industrially produced type; some potters make their own by punching holes in sheet-metal, such as, tin-plated iron. From the material remaining on the sieve (*moṭī miṭṭī*, "coarse clay"), stones and other reject material is removed by hand-sorting. The remaining lumps of clay are then mixed with the material that passed through the sieve (*bārīk miṭṭi*, "powdered clay"). Any small pieces of stone or grit that passed through the sieve are removed while throwing, if large enough to cause problems in throwing.

The clay is slaked (*galānā*, "to slake") in a pit dug in the earthen floor of one corner of a covered area of the workshop. The clay is placed in the pit and then covered with water, which over a period of one to two days completely moistens the clay. Excess water soaks into the earthen walls of the pit or evaporates from the surface of the clay. When the clay dries to a soft plastic condition (*thobī miṭṭī*, "plastic clay"), it is removed from the pit and spread out on an area of the workshop floor reserved for this purpose. If the clay is still a little too soft, some powdered clay is sprinkled over the surface and mixed in by foot-kneading (*miṭṭī nū latāṛnā*, "to mix with feet"). When the clay is at the correct stage of plasticity, dry sand (*ret*), which is sieved through a 20 mesh (about 1 mm aperture) sieve, is sprinkled over the clay and mixed thoroughly with the clay by more foot-kneading. Approximately 20 percent by volume of sand is added to the clay. Up to 300 kg of body is made up at one time. One potter throwing and turning continuously can use 100 kg of body per day maximum. The prepared body is stored under wet bags in a covered area of the workshop.

Forming and Finishing Techniques

The first stage in making any pottery is to hand-knead (*malnā*, "to knead") the body. A lump of about 5–6 kg is formed. Squatting on the ground, the potter rolls this lump into a cylinder and twists one quarter of the material from each end (one end in either hand) by twisting the hands in opposite directions. Raising his hands to shoulder height, he first beats one and then the other of these smaller lumps down onto the central lump remaining on the ground. After picking up the larger lump and turning it through 90° horizontally, he repeats the complete operation. After about 10 such cycles the material is ready for use.

All vessels produced in the pottery of Sardar Mahommed are formed by throwing on the potter's wheel. There are two wheels at the workshop, each of the usual pit-wheel type (Figure 3) with a wooden flywheel, wheelhead and shaft, and with the entire structure set in a brick-lined pit. This is characteristic of Panjabi pit-wheels in general, common fired brick being used to line the pit. As all vessels produced by this workshop are small, they are always thrown "off the hump." First, a lump of body weighing about 5 to 10 kg is placed on the wheelhead and roughly centered. A small portion at the top of the lump, sufficient for forming one pot, is centered and the vessel formed from this. The vessel is then cut off from the lump below, and further vessels are formed in the same manner until the large lump of body is exhausted.

Only four types of vessel are made at this pottery: *topī*; drinking bowls (*hāṇḍī*); lids for water pots (*ḍhakkan*, "lid"); and a fine decorative bowl (*piālā*). The latter bowl type, too thin-walled to be functional, is sold as a gift or souvenir, and is associated with the Gujrati potter's legend of Soni and Mahinwal (Plate 37*d*; Appendix 6).

All four of the products of this pottery are small in size. This specialization also is apparent by the making of lids but not the pots for which the lids are intended. The main product of the pottery is *topī*; these are produced continuously whereas the other three types are made only on order from pottery buyers.

The throwing of bowls and of two different shapes of *topī* was demonstrated. It was noted that the potter's wheels had been modified by replacing the bottom bearing, originally the steel point and stone cup type, with a ball bearing. This, coupled with the heavy wooden flywheel, gave the wheel good momentum, requiring only a minimum of kicking the flywheel during the forming operations. The potter kicks (*lāt mārnā*, "to kick") the flywheel (*cāk*) continuously while the top of the large lump of clay is being centered (*miṭṭī sīdhī karnā*, literally "to straighten the clay"). The amount of material needed to throw one pot is centered by squeezing the clay between both hands with the thumbs resting on top of the mass being centered. A hole is opened in the top center of the mass by pressing both thumbs together into the revolving mass. The bowls (*piālā*) are thrown with very thin walls (0.2 cm at the top). During throwing the rim of the vessel is always turned inwards, as it is on the final shape. With a thin-walled

vessel, such as this, it is extremely difficult to turn the rim inwards at the finish if the semiformed shape is tapered outwards at the top. *Topī* are formed from a tall cylindrical centered mass of clay with a height about three times its diameter. Only the top part of this shape, the bowl of the piece, is opened and thrown hollow; the bottom, stem section of the piece, is formed as a solid section. Decorative flanges are formed on the stem section by pressure of the fingers on the revolving mass of clay.

When throwing (*banānā*, "to make") is completed the forms are cut off (*kaṭṭ laiṇā*, "to cut off") from the larger mass of clay, using a cotton thread (*dhāgā*). This thread is kept in a dish of water near the potter's wheel during throwing. When ready to cut off a vessel, the potter takes the thread in his right hand and holds it between the little finger and palm of his hand. He marks a groove around the circumference of the pot at the point where it is to be cut off, and splashes some water into the groove. Then, with the free end of the thread resting over the index finger of his right hand, he touches the end to the groove at the base of the pot; the revolution of the wheel carries the thread around the pot. A quick pull towards his body causes the thread to cut through the pot. The thread is then put aside, and a slight touch of the potter's hand moves the pot off center to free it from the mass of clay below. He uses both hands to lift off (*pāse rakhnā*, literally, "to set aside") the completed vessel.

The next stage of forming is to turn the pots after they are sun-dried to leather hard, to remove excess clay from the base, and to complete the final shape of the pots. Three different turning tools are used. One, for shaping (*s̱hakal baṇānā*, literally, "to make the form") was a strip of mild or soft steel, thickness 16 gauge, with one end bent at 90°; the handle is 18 cm long by 2 cm wide, and the cutting end is 3 cm long by 2 cm wide. Another is exclusively for polishing (*cillṇā*, "to polish"); this tool resembles a knife blade, 16 cm long and 2.5 cm wide, with one end rounded; it also is made from 16 gauge mild steel. The third tool is a piece of cotton or other cloth, used for polishing the insides of bowls (*patīr phernā*, *literally*, "to turn with a cloth").

All four types of vessels made at the pottery are turned on the exterior. A clay, truncated conical chuck is formed on the wheel from plastic body. Vessels are placed upside down on this and turned. The turned area is polished, with the blade of the polishing tool being held at an oblique angle to the surface being polished. The interior of *topī* is also turned, and a hole is made through the long axis with a drill to allow free passage of smoke when the vessel is in use. Only bowls are polished on the interior with the polishing cloth. After the turning and polishing operations the vessels are placed in the courtyard of the workshop to dry in the sun.

Decoration

When dry, the pots are coated with a slip that fires to a red color. This slip is bought by potters at the bazaar of Gujrat from specialist pottery supply agents, who also sell other materials, such as pigments and glazes, and equipment such as stone querns. The slip is purchased in the form of a finely powdered yellow ochreous clay. For application, the potters simply place this powdered clay in a broad dish and add water, stirring until the slip achieves a creamy consistency. The slip is applied by pouring it over the bone-dry vessels. The vessels then are ready for firing.

Firing

The kiln used at the pottery workshop of Sardar Mahommed is of a type seen only in Gujrat. Dimensions and layout of the kiln are given in Figure 14. The kiln (*kūp*) may be described as a single chamber (*kūp kī golāī*) in the form of an inverted truncated cone surrounded by brick walls (*kangh*), the exterior of these walls forming a square. At the base of one wall is an opening in the brickwork, from which a tunnel (*cūmbrā*) leads to an opening at the base in the interior. The floor (*tallā*) of the interior is narrower in diameter than the base of the setting area, and is raised above the base so as to leave a channel (*khālī*) around the circumference of the base. In conjunction with the tunnel leading from the outside of the kiln, this channel supplies air to the base of the setting. A further channel or trough across the center of the floor serves the same purpose.

The kiln is of the type where fuel and pots are intermixed, but the refinement of an air supply at the base of the setting makes it a more sophisticated design than other kilns of Pakistan, where fuel and pots are set together without an air space. Sardar Mahommed's kiln is in one corner of the pottery courtyard, utilizing the two walls leading into the corner as part of the structure of the kiln and thus decreasing the cost and the number of bricks required to build the kiln, without changing its performance or operation.

This type of kiln is only used for firing small vessels. Other red earthenware potters in the Gujrat district, who produce large vessels, use the *āvī* type of kiln, which is common throughout the Panjab. The kiln at Sardar Mahommed's workshop is used

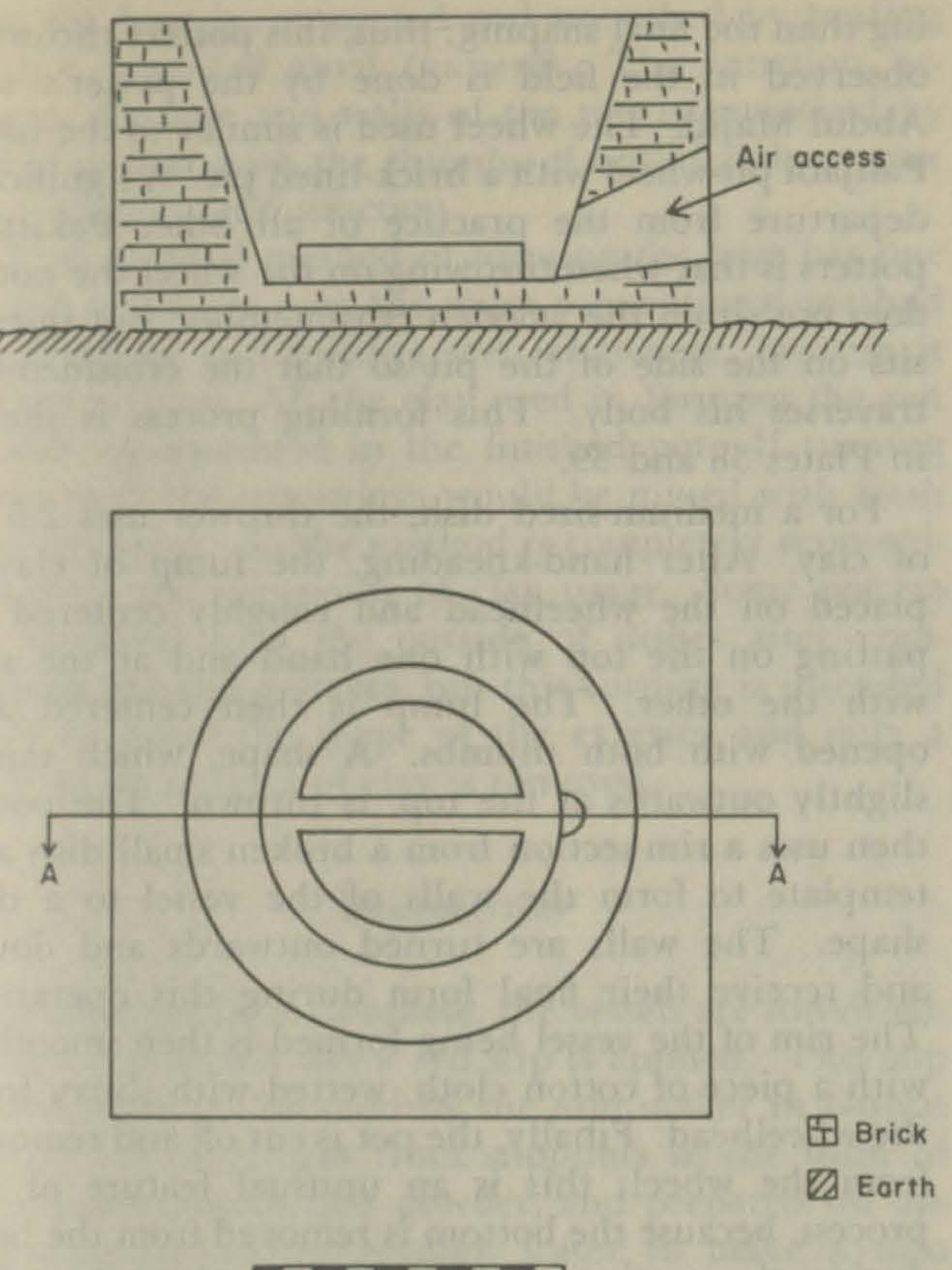


FIGURE 14.—Kiln (*kūp*) used by potter Sardar Mahommed of Garhi Maqbulabad, Gujrat: *top*, sectioned elevation A–A; *below*, plan.

by other potters, as well as by the two brothers. The two brothers produce enough vessels to fire the kiln two or three times a month, each time firing 1200 *ṭopī* or an equivalent number of other vessel types in a mixed firing. When the other potters use the kiln between times of firing of the brother's vessels, they pay a fee. At any one firing the kiln contains only the vessels from one workshop, otherwise there would be difficulty in deciding who would sustain the losses if vessels are damaged during firing.

Fuel for the kiln is dung. This is bought from suppliers; a limited percentage of the dung comes from the potter's own donkeys and buffalo. The dung is mixed with straw by women of the potter's family and formed into cakes, which are stuck onto walls of the workshop courtyard to dry (Plate 35*b*).

The first stage of setting (Plates 35, 36, 37) is to cover the air channels at the base of the kiln with pieces of tile or large sherds (*thīkrā*). These sherds are set in such a way as to prevent ash from falling down and blocking up the air channels, but with gaps wide enough to allow air to circulate upwards into the setting. A layer of sherds, broken from circular tiles, is then set around the side wall of the chamber in such a way that narrow air channels are formed up the walls. A layer of dry straw (*choī*) is then placed over the sherds at the base of the chamber and trampled down firmly to a thickness of about 8–10 cm.

On top of this, a layer of flat dung cakes, each about 15 cm in diameter and 3 to 4 cm thick, is set to a depth of 8–10 cm. These cakes (*paprī gohā*) are buffalo dung. The potter then sets a layer of donkey dung in the form of large balls, about 25 cm in diameter, which are broken into smaller pieces before setting them in place. The layer of donkey dung is about 10–15 cm deep after setting.

At this stage a wooden plank is placed across the top of the kiln. This plank acts as a working platform from which the potter completes setting the kiln without walking on the setting itself.

Then a layer of *ṭopī* is set. Women and girls of the potter's family carry the vessels from the workshop to the kiln and pass them to the potter, who sets all vessels in place himself. The first layer of *ṭopī* is 0.3 to 0.4 m deep. The vessels are laid on their side, very closely packed. The setting is kept approximately cylindrical rather than following the side walls of the chamber. The tapered gap between the setting and the walls is filled with pieces of donkey dung, and small pieces of dung are used to fill the interstices between pots. Another layer of flat dung cakes is set, leaving sufficient spaces among the individual pieces of fuel for good air circulation. The depth of this layer of fuel was about 20 cm.

The final layer of *ṭopī* is 0.5 cm deep. The method of setting is the same as that used in previous layers; all interstices between pots filled with small pieces of dung as is the tapered gap between the walls of the kiln and the setting of pots. After this layer is set, the setting is level with the top of the chamber walls at its periphery, and raised about 15 cm in the center. The top of the setting is then covered with closely packed sherds (*thīkrā*, literally, "pieces"), mostly lids damaged in previous firings. Over the top of all this a final layer of straw is placed; the first 8–10 cm of this layer is dry straw and the upper 10–15 cm is damp or wet straw. The setting is then complete. The total time taken for setting is three hours.

The firing is started from the airhole at the front of the kiln. Some bark and straw are placed near the base of the setting through this opening and lighted (*agg lagāṇā*, "to light a fire"). A little more bark and straw is added as the initial material burns away. After five minutes, the straw and dung at the base of the setting begin to smoulder, after which no further fuel is fed into the airhole. The kiln is unattended from that point onwards. It takes about three hours

for the dung and straw fuel to burn. The kiln is set and fired in one afternoon and allowed to cool overnight before removing the fired pots the next morning. Total fuel consumption for one firing containing about 1200 *ṭopī* is 4 to 5 maunds of dung and 1 maund of straw.

As the potter removes the fired vessels from the kiln the next morning, he inspects each one and rejects those that are cracked or otherwise damaged. Total losses for this demonstration firing were 20 *ṭopī*, several of which were broken while setting the kiln and the others during firing. This represents less than 2 percent setting and firing loss, an extremely high yield of well-fired vessels. Sardar Mahommed said that firing loss is typical; so this type of kiln and setting is very efficient.

Shadiwal Village

The village of Shadiwal is 18 km to the southwest of Gujrat city near the Chenab River. The village is unusual in two respects: First, most of the villagers are potters; and second, only one type of pot is produced, i.e., large flat-bottomed dishes, call *"kunālā."* Specialization to this extent is not seen among potters anywhere else in Pakistan. An exact census of the number of potters in the village could not be obtained, but several potters indicated the total to be of the order of 200 families. The potters are specialized to such an extent that they do not even produce other types of vessels for their own use; all other vessels, such as water pots and cooking pots, are imported from Gujrat city.

The dishes are made in three sizes, with diameters of 27, 35, and 40 cm. The larger sizes are used domestically for mixing flour (*āṭā*) and water to make dough for *capātī*, the bread of Pakistan. The smaller sizes are used for making curd (*dahī*), normally made from goat's milk.

Forming and Finishing Techniques

Kunālā are made at the workshop of Ala Dita, who is said by other potters of the village to produce very good dishes. A local clay is used, without the addition of nonplastics. It is prepared by drying, breaking up into fine lumps, and adding water to a hollowed conical pile. When thoroughly wetted it is foot-kneaded to a uniform consistency, and is further hand-kneaded before throwing.

Throwing is used only to form blanks, which after drying slightly are completed to form dishes. Throwing is considered to be a less skilled part of the forming than the final shaping; thus, this pottery throwing observed in the field is done by the potter's son, Abdul Majid. The wheel used is similar to the usual Panjabi pit-wheel with a brick-lined pit. A significant departure from the practice of all other Pakistani potters is that when throwing on the wheel the potter does not sit on the wooden crossmember, but instead sits on the side of the pit so that the crossmember traverses his body. This forming process is shown in Plates 38 and 39.

For a medium-sized dish, the thrower uses 2.5 kg of clay. After hand-kneading, the lump of clay is placed on the wheelhead and roughly centered by patting on the top with one hand and at the side with the other. The lump is then centered and opened with both thumbs. A shape, which tapers slightly outwards at the top, is thrown. The potter then uses a rim-section from a broken small dish as a template to form the walls of the vessel to a dish shape. The walls are turned outwards and down, and receive their final form during this operation. The rim of the vessel being formed is then smoothed with a piece of cotton cloth, wetted with slurry from the wheelhead. Finally, the pot is cut off and removed from the wheel; this is an unusual feature of the process, because the bottom is removed from the bowl during the cutting off. To do this, the potter first marks a groove on the outside of the vessel with his fingernail, while the wheel is revolving slowly. This groove is above the level of the inside base of the pot. He then takes a cotton thread, and touches one end of this to the groove. As the wheel revolves it carries the thread around the vessel; the other end, held firmly in his right hand, is pulled away, causing the thread to cut through the pot. The upper part, the side walls of the dish with no base, is then lifted from the wheel. The clay remaining on the wheelhead is left in place and the lump of clay for the next vessel is placed directly onto it.

After the baseless dish dries to a soft leather-hard condition, it is completed by the older and more experienced potter. The walls of the dish are thrown so that they are at their final thickness near the rim, but are thick (about 3 cm) near the base. Ala Dita squeezes this material near the base inwards towards the center, thinning the walls and forming the base at the same time. When the hole at the base is closed over by this material, which moves inwards, the base is somewhat uneven in thickness. He then moves the dish onto a circular batt of biscuited clay. The top, working surface of the batt is dusted with dung ash, obtained from the kiln after previous firings. The dusting of ash prevents the base of the dish from sticking to the batt. The dish is placed on the batt,

and the base is compacted and smoothed by beating with a biscuited anvil (*kunerā*). The junction between the base and walls of the pot is smoothed by rubbing over with the thumbs of both hands to give an evenly curved junction.

This unusual method of forming the base has one major advantage over the more conventional method of throwing and turning seen elsewhere, because it wastes no clay. All the clay used in forming the pot is still incorporated in the finished pot. If turning were used, the trimmings would be mixed with fresh clay for reuse. So the method is completely economical from the viewpoint of clay usage. Some potters in Shadiwal turn the outside of dishes after completing the above stages, but this turning is intended only to refine the shape of the exterior and only a very small amount of clay is removed.

Decoration

After forming is complete, the vessels are sun-dried. When completely dry a red slip is applied. This slip is the same as that used by the *topī* maker in Gujrat (p. 58). It is bought from suppliers in the form of a yellow ochreous clay powder, and prepared for application by adding enough water to make a thin slip. This slip is applied to the dishes by dipping.

When the vessels are again dry, they are decorated with a black pigment. In Shadiwal this painting is always done by women; at the pottery workshop of Ala Dita all the dishes are decorated by his daughter, who is nine years old. She uses a brush made from donkey mane. The black pigment is mixed with water in an earthenware dish. She sits on the ground to work, with the dish placed on a turntable so that the top of the dish is 25 cm above the ground. Revolving the dish with her left hand she paints patterns in bands and in free brush strokes paints it in repeated rhythms around the dish. The pattern is varied on each dish to give a seemingly unlimited variety of combinations. On some 2000 dishes at the pottery no two are alike in decoration. The basic decorative elements are combined differently on each (Plate 40). The girl takes less than a minute to decorate each dish. When the decoration is completed, each dish is placed on the ground in a large drying area about 40 by 30 m and left there until removed for setting in the kiln (Plate 39*d*).

Firing

The kiln type used in all the potteries of Shadiwal is the *āvī*, a general type used widely over the Panjab. Its general characteristics: built above or slightly excavated below ground level; three low walls, two side walls equal in length, back wall about half the length of the open front, that is, side walls converge towards open front; floor slopes upwards, slope about one in five from ground level at front to high point at back wall. A typical Shadiwal *āvī* is shown in Plate 39. Basically, the *āvī* is a long narrow sloping pit-kiln, but for convenience of construction it is usually not excavated as a pit, but built above ground level with low walls substituting for the sides of an excavation. In Shadiwal the kiln at each pottery is of the same basic type, but a variety of construction materials and methods are seen. The simplest *āvī* is excavated on a sloping floor. Others are built up on level ground, by first building the sloping floor from earth fill, and then building the low, 1- to 2-m walls from mud and straw. In the example shown in Plate 39*d*, the walls are constructed from *kunālī* wasters, placed upside down. The gaps are filled with mud-and-straw mortar. More sophisticated versions have rubble brick floors and walls of brick bonded with clay mortar. Average dimensions of the Shadiwal *āvī*: length, front to back, 10 m; width at back, 5 m; width, at front, 1.5 m; height above ground level of floor at front, nil; height above ground level of floor at back, 2 m; height of wall above floor on interior, 1 m with the exterior height of walls dependent on the ground level: In Shadiwal the kiln is fired with dung fuel.

The kiln at the workshop of Ala Dita is constructed on level ground. The walls are of fired common brick, each wall being 23 cm thick. The back wall is 2 m high, the side wall tapered from 2 m high at the back to 0.6 m high at the front. Exterior width at the back is 3.5 m, at the front 1.3 m. A sloping earth floor is constructed inside these walls, tapering from ground level at the front to 1 m at the back.

The kiln is set in layers. First, a layer of straw is placed on the sloping floor of the kiln and compressed to a depth of 0.2 m. Then a layer of buffalo dung (donkey dung is used sometimes) 0.2 m thick is laid down on the straw; the dung is in the form of lumps averaging 10 cm in diameter. On this dung layer, the dishes are set, standing almost vertically on their edges. The stacks are alternated so that the dishes all support one another: a stack of 12 to 14 dishes is set, then another stack of 12 to 14 is set at right angles to the first stack, and so on. Viewed from above, the final setting has a checkerboard appearance. The stacks are kept at least 0.2 m away from the walls of the kiln, with all dishes at the outer edges of the setting leaning inwards. The dishes are then covered completely with a layer of dung (0.3 m deep), which

fills all the gaps between stacks of dishes and the kiln walls. Finally a brickwork structure five bricks high and one deep is built across the front of the setting. Gaps are left at the base of this wall to allow air to circulate to the front of the fuel setting. The setting is done by a male member of the potter's family who is fully employed setting or drawing the kiln, or packing dishes for sale and shipment. Setting the kiln takes one full day in which 1000 dishes are set and 15 maunds of dung are used for the one firing.

The fuel is ignited by lighting a small fire at the front and the dung begins to smoulder within a few minutes. The fuel burns slowly from the front of the kiln to the back in about 24 to 36 hours, depending on setting and weather. The setting is allowed to cool for a further three days before removing the dishes. Firing losses are said to be sometimes as high as 50 percent.

The dishes are usually sold to traders in Gujrat city. The traders send trucks to transport the dishes. From Gujrat the *kunālī* are distributed all over the Panjab and even into lower parts of the Northwest Frontier Province. Three typical dishes from Shadiwal, purchased in Gujrat bazaar for the collection of the Smithsonian Institution's Department of Anthropology, are shown in Plate 40.

AHMEDPUR EAST, PANJAB

Pottery from Ahmedpur East is well known to Pakistanis as Bahawalpur pottery, Bahawalpur paperweight pottery, or Bahawalpur paperfine pottery; it is widely considered within Pakistan to be very fine work and prized particularly for its light weight. For consistency within the present work, the term, "paperfine ware," is used.

Because the ware is well known some misunderstandings have arisen. The terms such as "Bahawalpur pottery," have led people to believe that the ware is actually made in Bahawalpur city, whereas it is actually produced in Ahmedpur East, some 50 km southwest of Bahawalpur by road. Other types of ware are also made in the region, but because they have not been studied in detail the present discussion is limited to the paperfine ware. For comparison some other types are reported briefly below.

It was not possible to obtain an accurate estimate of the number of potters working in the Bahawalpur-Ahmedpur East region, and there was no time for a census. Several potters reported a total estimate of 100. Some 10 to 15 potters in Ahmedpur East are making the paperfine ware, within 6 or 7 workshops. Each workshop has at least one assistant working at an unskilled level.

The makers of paperfine ware are full-time potters, working all year round. Because their ware is in constant demand there is not any period during the year when production lessens. Several potters operate shops in Ahmedpur East, selling on both a retail and wholesale basis. Estimate of production and distribution statistics are unavailable.

The difficulty of obtaining data was greater in Ahmedpur than in any other area covered by the present monograph. As has been mentioned in the introduction, most of the data reported in this work was obtained with the cooperation and consent of the potters concerned. Some potters were reluctant to reveal some of their techniques which they consider as trade secrets. The authors' attitude is that there is an ethical obligation to the potters to report only the data which the potters are willing to impart, and not in any way to press the issue regarding their trade secrets. The potters of Ahmedpur East feel strongly that many details of their work are not to be revealed. For that reason alone the data from Ahmedpur is both limited and generalized compared to that from other areas.

The potter's craft is hereditary patrilineally, the eldest sons of potters being expected and trained to become potters. When a potter retires his son inherits the workshop.

The workshops visited are generally of similar layout to many other Pakistani potters' workshops, in that the pit-type wheel is under a sheltered awning. Only in one workshop, the wheel was placed inside a room. Vessels are formed under shelter and then dried in a courtyard; assistants carry vessels from one location to another between operations.

MATERIALS GATHERING AND PREPARATION

It was not possible to inspect the clay deposit. Potters said that two different types of clay are used, one for the paperfine ware and a different type of clay for the ordinary unglazed earthenware for domestic use. Clay for paperfine ware is said to be obtained from silt deposits resulting from the flooding of the Sutlej River. Inspection of a clay sample showed it to be fine and free from grit. The clay is used without admixture for making pottery. It

is prepared by the usual Pakistani methods: sun-dried, larger lumps broken up with a stick, placed in a hollowed pile and moistened, and kneaded by foot and finally by hand before use.

The potters of one workshop referred to the use of a black stone, to be mixed with clay for the body of one of the two types of paperfine ware. The two types are blackware and orangeware, both having similar shapes and decorative patterns, differing basically only in the color of the ware. It was not possible to obtain, or even to see, a sample material at the workshop. No unfired ware of darker color than the normal was seen at the pottery. Specimens of Bahawalpur black paperfine ware, when later reheated to above 600°C in the laboratory, in the presence of air became orange and are similar in all respects after microscopic examination to the orangeware. All indications are that the report of so-called additions of any black stone or mineral to the clay to produce the black paperfine ware is spurious and the sole cause of the black color is firing procedures.

Forming and Finishing Techniques

Paperfine ware is usually formed by throwing parts of vessels separately and then joining them when they dry to leather hard; some ware is molded wholly or in part.

The first stage of forming is kneading the clay. Taking about 5 kg of clay, the potter rolls out a cylindrical lump on a wooden platform placed near ground level. Moving his hands to the ends of the cylinder, he rolls the ends to a smaller diameter than the center. The ends, each about a quarter of the total, are then cut off and beaten down onto the center. The cycle is repeated 10 to 15 times before the clay is ready to use.

The potter showed how a ewer (*kūzā*) is formed by first making parts of the vessel separately and then joining them. The main body of the vessel is thrown on the wheel, the form being torus-like (actually the section was D-shaped with the flat side to the center). The torus-like shape (*capṛī*) is cut from the wheel and placed aside to dry to leather hard. To cut the vessels free from the wheel the potter uses a twisted thread (*cīn*), which he ties at one end to the second finger of his left hand. The free end (about 16 cm long) of the cotton thread rests over the back of the potter's hand while he is throwing. To cut off a form, he touches the free end of the thread to the base of the vessel where it is to be cut through. As the wheel revolves, it carries the thread around the vessel; a direct pull toward the potter's body causes the string to cut through the vessel. The potter steadies the vessel with his free, or right, hand and then, using both hands, lifts it from the wheelhead, placing it aside to dry to leather hard.

The second stage of forming is to make the spout for the *kūzā*. A smooth, straight stick 1 cm in diameter and 20 cm long is used in this forming operation. First, the potter forms on the wheel by throwing a cylinder of clay about 8 cm high and 3 cm in diameter. Then he wets the stick with slurry and pushes it vertically downwards through the center of the clay cylinder. The clay is then manipulated so that the walls of the spout are formed around the stick by moving the clay up along the stick. The walls of the spout are thinned to their final thickness by this process. This is a common way of forming a spout and in fact is well known among modern studio potters in many countries. The spout and stick together are cut from the wheel, and clay is cut away from the bottom of the stick so that both ends of the stick are exposed. The potter then carefully holds the outside of the clay spout in one hand and revolves the stick slightly inside the spout with the other, to insure that the stick is not stuck to the clay. Still holding both the stick and the spout, one in either hand, he then withdraws the stick, leaving the spout free. The spout is then bent to its final shape and set aside to dry to leather hard.

The neck of the *kūzā* is thrown next. Decorative bands are incised when the shape is completed, but still revolving on the wheel. The neck is then cut off and set aside to dry.

The remaining parts of the *kūzā* are not wheel formed. Two slightly convex discs, which form the sides of the *kūzā*, are pressed into fired, unglazed, sometimes called biscuit, molds. The molds have decorative patterns incised on the interior; the cast thus has relief decoration, about 2 mm high. At the first stage in forming the disc, clay is pressed into the molds, and set aside to allow the clay to dry slightly before removal. Excess clay is removed from the mold, while it is still soft, by running an index finger around the edge of the mold and scraping it off. Then the handle is formed from a coil of clay about 1.5 cm in diameter. It is held vertically in the left hand while the potter shapes the section of the handle with the wetted fingers of his right hand. The handle is then placed aside to dry to leather hard. Finally the pedestal foot of the *kūzā* is formed from a ball of clay by hand modeling, and later by carving to shape.

In normal production, the potter does not form the parts of one vessel in sequence, but schedules his work so that he produces a number of spouts,

handles, and so on simultaneously, accumulating enough of the various pieces to produce several vessels. The actual number of similar pieces, such as spouts formed at one time, is dependent on drying times; the work is regulated so that in each group of pieces, the first-made are dried to leather hard and joined while the last-made are still drying. In this way no pieces dry beyond the point where they are usable for joining.

For joining, first the torus-shaped body of the ewer is placed on a clay chuck on the wheelhead, and turned to remove excess clay from what originally was the base of this part when thrown. When the cross-section is circular (except for the flat interior face), one of the side discs is placed in position and joined, with the wheel revolving slowly at first and then faster when the disc is pressed firmly into place. Some slurry is applied at the joint as a lubricant. The potter incises decorative grooves with one fingernail to complete the joint. The whole piece is then lifted from the wheel; the other disc is then joined in the same way.

Up to this point the piece rests horizontally on the soft clay chuck. It is removed and placed so it stands vertically in the chuck. A hole is cut at the top where the neck is to be joined, then the leather-hard neck of the pot is placed in position after wetting both the mating surfaces with slurry.

With the wheel revolving, the potter joins the neck to the body of the pot, pressing overlapping clay from the neck firmly against the body section and smoothing the joint. He then removes the semiformed vessel from the wheel. The base or foot is joined after the mating surfaces are scratched to roughen the surfaces and insure a complete bonding.

The spout and finally the handle are added. The potter cut a hole in the vessel where the spout is to be added, and trims the spout with a steel knife so that the area to be joined fits closely to the body of the *kūzā*. He then joins the spout by pressing firmly into place and smoothing the joint with the fingers. After joining the handle in the same way, he then sets the *kūzā* aside to dry. When it is bone dry all joint seams are smoothed with a damp cotton cloth, and the areas of the pot not having relief decoration are also smoothed.

One potter said that when all the pieces of the vessel are joined together and the joints smoothed, but before the vessel is completely dried, he polishes the undecorated surfaces with a quartz pebble. The resulting vessels have a finer surface than the ones that are not polished. Polishing the surface is done by some of the pierced ware potters and not by others; finished vessels that are not polished still have visible forming marks. All vessels that are turned are polished with a smooth quartz pebble on the area which is turned.

It was noted that molds are used to form parts of the ewer. Molds also are used in forming parts of other vessel types when it is possible to form a relief-decorated shape.

Examples of such shapes are the *kūzā* already cited (partly molded, Plate 42*c*); *surāhī* (partly molded, similar basic form to *kūzā*, Plate 42*a*,*b*); *mukīdāṇ* (dish with lid, the lid partly molded, Plate 44*b*). Molds for the latter are dish-shaped, with the pattern incised on the interior; at the apex, a hole 3 cm diameter allows removal of a disc of clay from the lid at the time of molding. The knob is later joined at this point by throwing. At the same time, a concave disc of clay is joined to the underside of the lid, around the inside of the flange. Thus the lid is double walled. The completed lid is allowed to dry in the mold (Plate 41*d*).

Other paperfine ware vessels are made without the use of molds. Examples of such types are: a *surāhī* (formed by joining three thrown sections, Plate 43*a*); a plate or wall plaque (formed by throwing and turning with a central motif formed by pressing a seal with incised pattern, Plate 44*a*); a *guldān*, flower vase (formed by throwing and turning, Plate 44*c*); another *guldān*, flower vase (formed by throwing in three sections, turning, joining, Plate 43*b*). The relief decoration on all of these unmolded vessels, with the exception of the central medallion on the plate, is carved individually on each piece. During the forming, a band is left in relief on each vessel; a pointed steel tool is used to carve down to the level of the surrounding area of the vessel wall, leaving decorative relief standing the height of the original bond (Plate 44*d*).

Paperfine ware can be divided into two major groups: One group is the molded type, where the parts of the vessel with relief decoration are molded in a biscuit mold. Vessels in this group characteristically have a double wall, the outer wall being pierced. The second group is the carved type. Vessels in this group characteristically have a single-walled form, which may or may not be pierced. Apart from the presence or absence of a double wall, vessels from the two groups may be differentiated by close inspection of the relief decoration. When the relief is molded, edges tend to be slightly rounded; where the relief is carved, edges are sharp and segments of the relief are much more sharply delineated. In the latter group, markings from the steel knife used to carve the decoration are clear and sharp, especially on inner curves; in the molded group these markings

are on the exterior of curves. The original molds are carved in the same manner as carved vessels so markings on the cast are reversed.

Decoration

Piercing is done after the vessels are bone dry. Using a sharp-pointed steel tool (*nerār;* Plate 44*d*), the potters cut completely through the vessel wall at joints of the relief decoration where the wall is thinnest; that is, in the intersections of the valleys of the relief decoration. The holes resulting from this piercing are small in diameter, normally 0.2 to 0.4 cm, with the larger holes uncommon; but the final effect in combination with the relief decoration is one of a distinctive perforated pattern strongly accentuating the relief decoration.

When vessels are finished to the stages just described, they are coated with a micaceous slip. According to the potters, the raw material for this slip is obtained from a locality near the clay source on flood plains of the Sutlej River. Inspection of a sample of the material before preparation shows a minor content of fine quartz grains and silt, with the primary mineral a white mica, probably muscovite. No other minerals are added to this raw material, which is prepared by grinding in a stone mortar with a double-ended wooden pestle.

For application the micaceous powder is suspended in water. It requires only occasional stirring to insure that it remain in suspension. The slip is applied to bone-dry vessels, by pouring it over the entire vessel (Plate 41*a*), or in the case of smaller vessels by dipping the vessel in the slip.

Vessels fired as blackware are ready for firing at this stage. Vessels fired as orangeware receive further decoration. Pigments are applied in bands or dots, to accentuate areas of the relief decoration on certain vessels. Three pigments are used: black, white, and red. Both the white and red pigments are clays.

The pigments are all prepared in the same way. The raw material is ground with a stone mortar and pestle to a fine powder, that is mixed with a little water. The pigments are applied with a brush made from donkey-mane or camel-hair. Bands of color are put on while the vessel revolves on the potter's wheel (*cak*). Other types of decoration are applied freehand.

Firing

Each workshop has at least two kilns, one for orangeware and one for blackware, exclusively. Although both types of kiln are of similar design, dimensions, and construction, they are not used interchangeably. The dimensions of one kiln (*bhaṭṭī*) are shown in Figure 15. The structure is extremely simple. A circular hole is dug as the first stage of construction. Several courses of bricks are laid around the perimeter of the hole, continuing the circular plan. This section becomes the firebox, so an opening is left at one side for the stokehole. A circular slab, with diameter equal to that of the outside diameter of the brick work, is laid across the top of the firebox. This slab, made from mud and straw, has a series of holes, which act as flues between the firebox below and the chamber above. A flat course of bricks is then laid on top of the mud and straw slab. The bricks are set with gaps corresponding to the flue holes in the mud-and-straw slab. These holes in the brickwork are lined with clay to make them circular in order to correspond to the holes in the slab below. A further coating of clay, mixed with straw, is then plastered over the course of bricks. Holes are also formed in this layer, so that the flues connecting firebox and chamber are continuous. The final thickness of the chamber floor is about 23 to 24 cm, made up of 8 cm thickness in the bottom slab, 7.5 cm thickness of bricks, and a further 8 cm in the upper layer of clay.

The chamber is constructed from bricks by adding circular courses at the perimeter of the structure comprising firebox and chamber floor. The chamber is a simple cylindrical shape, with no closure at the top. Finally, the complete structure is coated with a mud-straw plaster, inside and out, and the stokehole is formed to an arched shape using the mud-and-straw mixture.

This type of kiln is the simplest updraft structure seen in Pakistan. It has the advantages of being extremely easy to build and repair. A disadvantage is that the structure of the chamber floor is only suitable for small kilns; in a larger structure this type of floor would crack and possibly collapse. The chamber diameter of the interior of kilns seen at Ahmedpur varies from 0.6 to 1.10 m. Even with kilns of such small dimensions the chamber floor cracks extensively the first few times a kiln is fired, necessitating extensive repairing before the structure is stabilized.

Considering the type of ware being fired, it is understandable that the Ahmedpur East kilns are of small size. The pottery is fragile before firing, and is broken extremely easily. As it is set in the kiln by stacking vessels one on top of another, without the use of any props or shelves, there is a natural limit on the size of the setting. According to the potters, if

the pots are stacked higher than about 1 m, then the pots at the bottom of the stack are crushed by the weight of pots placed on them. For this reason the kilns are limited in size. Thus, the potters use very simple kiln-building techniques, such as the floor construction already described, without resorting to the more complex structures necessitated by a larger overall size, such as those at Zakhel Bala (pp. 83–86) and Hala (pp. 110–114).

The potters said that this type of kiln has been in use as long as they can remember; one potter reported that this type of kiln is constructed in exactly the same way as kilns his grandfather had seen as a youth; in fact, the grandfather had supervised the construction of his kiln.

Depending on the types of vessels being fired, there are 30 to 100 vessels in a firing at the pottery (Figure 15; Plate 41). Each kiln is fired every 7 to 10 days. The fuel is wood, consumption of which is one maund (about 50 kg) per firing. The fuel is purchased from suppliers at 4 rupees per maund. The potters use any type of fuel wood that is available.

When the setting is completed the opening at the top of the kiln is covered with a mud-and-straw slab with perforations to act as flues. The orangeware is

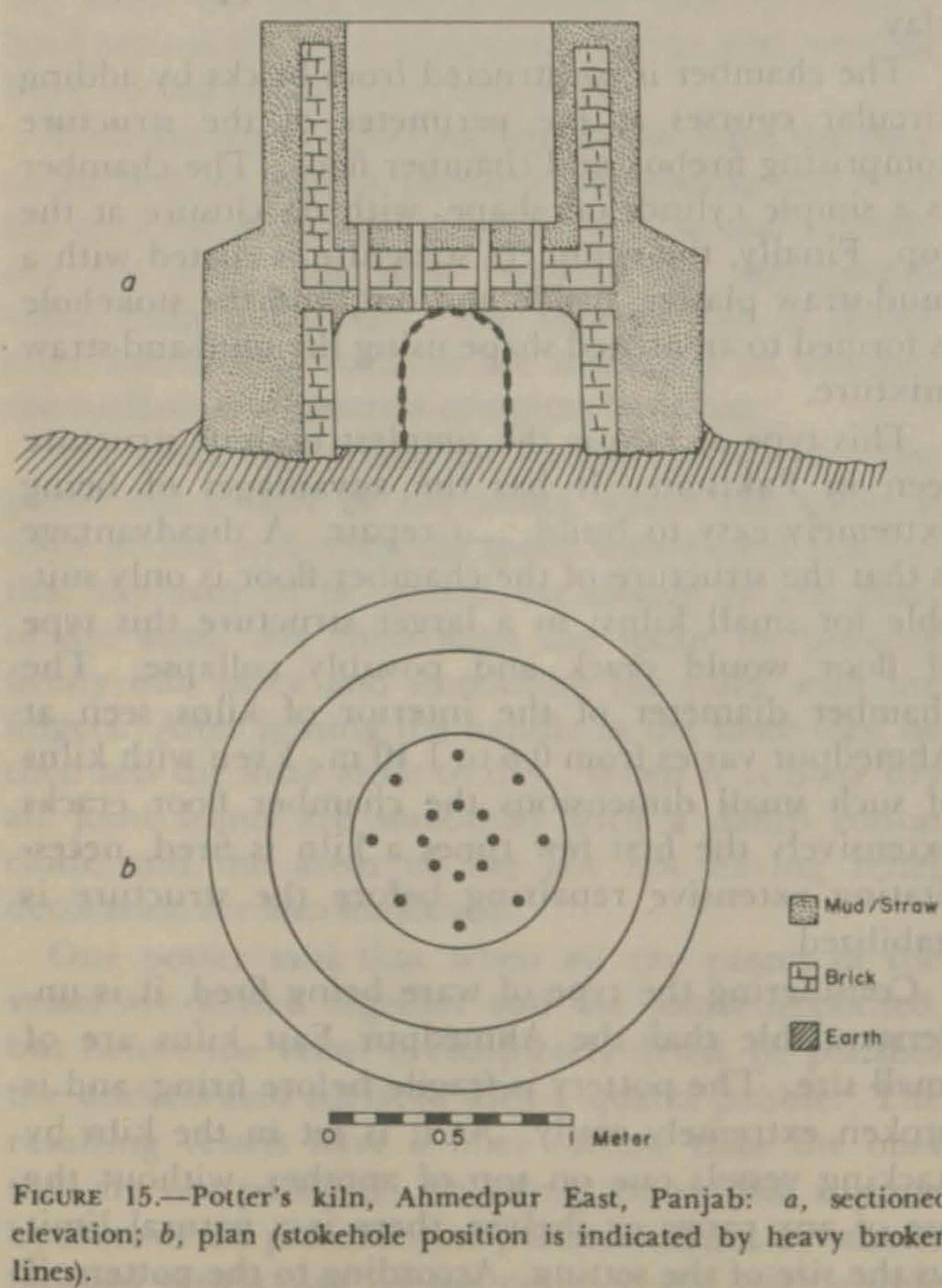


FIGURE 15.—Potter's kiln, Ahmedpur East, Panjab: *a*, sectioned elevation; *b*, plan (stokehole position is indicated by heavy broken lines).

fired with a clean, oxidizing fire. At one workshop an orangeware kiln had the stokehole loosely sealed with bricks, indicating that at the end of firing the kiln is partly sealed to slow the cooling rate, but that a minimal air flow through the setting allows the pottery to cool in circulating air to retain the orange color.

The potters are extremely reluctant to discuss firing techniques for the blackware, but much of the process appears normal without any complex or secret procedures. The kiln differs in no way from that used for orangeware. The same wood fuel is used. It has been shown by reheating experiments (p. 63) that the black color of pierced ware vessels is due solely to carbon in the pores of the vessels. Duma and Lengyel (1970:71) have found that carbon is deposited in pottery from carbon monoxide gas, not from smoke or sooting. Deposition is gréatest in the temperature range of 400° to 600°C, continuing significantly to 800°C. Carbon monoxide gas is only present in a kiln if the air supply is limited, thus creating neutral or reducing firing conditions. Carbon deposition varies with the fuel used; the data reported by Duma and Lengyel (1970:72–76, fig. 3) indicate that wood fuels with a high volatile content produce more carbon deposition than other fuels, such as dung or straw.

The firing technique for the blackware of Ahmedpur East may be reconstructed as follows: It is suggested that the kiln is fired similarly to that of the orangeware until a temperature of perhaps 500°–600°C is reached. This temperature range is suggested because it is within the temperature range for maximum carbon deposition; and it would be easy for a potter to judge when this temperature range is reached because it is the range of lowest visible red heat in a kiln, not requiring instruments to measure. At this point the air supply would be restricted. This can be achieved by a number of methods: By completely or partially closing the flues in the mud slab at the top of the kiln, the draft and consequently air flow into the kiln would be stopped. Alternately, or perhaps also, the stokehole could be partly sealed with loose bricks. A third alternative would be that another material is introduced into the firebox, such as wet straw, which would restrict access of air to the fuel. The latter technique is less likely since this would tend to halt or to decrease markedly the temperature rise.

One or another of the three techniques would insure that carbon is deposited in pores of the vessels. This deposition would serve no purpose if the ware were allowed to cool in the presence of air; in that case the carbon would be burned out again as the

vessels cooled in the kiln. So the next stage would be to insure that the carbon that is deposited during heating is not burned out (oxidized) during the cooling. The method of restricting access of air to the vessels is obvious from a kiln seen at one pottery (Plate 41*b*). This kiln had been fired recently, and the vessels removed, but it was evident that the stokehole had been completely sealed with bricks and then plastered over with clay while the kiln was hot and that the mud slab covering the top of the kiln had been sealed by a coating of clay around the edges to form an airtight seal preventing any draft through the kiln. So it is apparent that the kiln had been sealed, presumably at maximum temperature and probably with some wood fuel remaining in the firebox to produce carbon monoxide; the kiln would then cool slowly while remaining sealed. Below a temperature of about 500°C the carbon would not oxidize appreciably even in the presence of air so the kiln could have been opened at any stage after it had cooled below that temperature without affecting the black color.

It was noted that the Ahmedpur East blackware was not colorfast after firing, but that the black color would rub off the surface easily. A potter explained that when the ware is drawn from the kiln, it is washed and scrubbed with a bush to remove excess carbon from the surface. Even so vessels of this type have some excess carbon remaining on the surface at the time of sale. This carbon would normally come off of the surface from the repeated handling after the vessel is in use for some time.

Miscellaneous Pottery Types

To this point only the contemporary paperfine ware pottery of Ahmedpur East has been discussed. Other types of ware were observed in the Bahawalpur-Ahmedpur East area: an older type of paperfine ware and the utilitarian village pottery.

One potter, Swali Mahommed has in his possession a vessel which he said represented a type made in Ahmedpur East before the twentieth century; this particular piece was made by his grandfather. This older type of paperfine ware has a very vitreous body with an appearance which could almost be described as glasslike. The body is black, extending completely through the wall of the vessel as seen on a broken cross-section. Because of vitrification the surface has the appearance of having a glaze applied, although this is not the case, so the body could be described as "self-glazing." The vase has a band of relief floral pattern, similar in design to some of the recent paperfine ware patterns, but of much finer and detailed workmanship. The appearance of the vessel suggests that it was fired in a similar manner to that of the present-day blackware, carbon having been deposited while the ware was still porous and being prevented from burning out by subsequent vitrification of the body. The potters would not allow Rye to photograph the vase, or to examine it in detail.

The ordinary village ware, or utilitarian domestic pottery, of Bahawalpur and Ahmedpur East, shows some influence from the older paperfine ware. In style, it is superficially similar to many Sindhi pottery types, in that it commonly has banded red and black decoration, including wavy bands. The older paperfine ware influence on Bahawalpur village pottery shows up in the use of white pigment in fine dotted and banded decoration, as well as the use of micaceous slips. A water jar from Bahawalpur with these decorative elements is shown in Plate 45*c*. The red, black, and white pigments are identical to those used on the older paperfine vessels. Dishes (Plate 45*a,b*) also show the influence from older paperfine ware pottery in the floral motifs and detailed decorative style.

The utilitarian *surāhī* of Ahmedpur East is mold-formed by similar techniques to those of Quetta (Plate 53) and has a foot-ring. This foot is added to vessels at the leather-hard stage by one of two methods: A foot is thrown in the form of a shallow bowl and then joined when the pot and foot are leather hard, or the water jar at leather-hard stage is placed upside down in a chuck on the wheel and the foot thrown from a coil of clay joined to the base of the pot.

In the above discussion, two major categories of paperfine ware have been isolated: the molded group, which is characterized by sections of the ware with relief decoration having been mold-formed; and the carved group, with carved relief decoration. Vessels in the molded group are characteristically double-walled with the outer wall perforated. Vessels in the carved group are characteristically single walled, the wall either perforated or not.

Two further subgroups can be isolated: blackware and orangeware. Vessels in either of these subgroups may be of either the carved or molded groups; the distinction between black- and orangeware is primarily that of color rather than vessel type. The only exception is that of utilitarian ware, such as bowls and drinking cups, which are never produced as

	PAPERFINE WARE				UTILITARIAN DOMESTIC WARE	
TYPE OF WARE:	Molded		Unmolded		Fine	Coarse
FORMING:	Some sections molded, others thrown, turned; joined; may have double wall (outer pierced, inner contains fluids)		No molded sections; thrown, turned, joined; single wall		Thrown, turned; single wall	Thrown, turned or paddle and anvil; coarse molding
PLASTIC DECORATION:	Fine floral motifs in relief (molded); pierced		Fine floral motifs in relief (carved); some pierced (nonfunctional)		Occasionally incised or impressed bands; often none	If coarse, mold relief otherwise none
SLIPS:	Fine micaceous slip		Fine micaceous slip		Fine micaceous slip	No slip or red slip or coarse mica
BRUSHWORK DECORATION:	None	White, red, black	None	White, red, black	None	White, red, black
FIRING:	Blackware	Orangeware	Blackware	Orangeware	Orangeware (never black)	Not in updraft kiln (never black)
EXAMPLES:	USNM 417,171	USNM 410,652-O (Plate 42a,b); USNM 417,174 (Plate 42c); USNM 417,169-A (Plate 44b)	USNM 410,652-N (Plate 43a); USNM 417,164 (Plate 43b); USNM 417,167 (Plate 44a); USNM 417,174 (Plate 44c)	USNM 417,170 (Plate 43c)	None in USNM collections	Not in USNM (Plate 45a); USNM 410,652-G (Plate 45b); USNM 410,652-H (Plate 45c)

FIGURE 16.—Classification of unglazed ware at Ahmedpur East, Panjab.

blackware. (A diagram of vessel types is shown in Figure 16.)

The paperfine ware, particularly the pierced vessels, show a very strong influence from metalwork. Pierced copperware is still commonly produced in Pakistan, so it is not possible to say at this point when the influence began. The reader familiar with pierced metalware of Pakistan and other Islamic countries will note the strong influence on vessels, such as those shown in Plates 42 and 43. The Ahmedpur East ware may thus have originated as a poor man's metalware substitute.

ASSOCIATED CLAY PRODUCTS

Brick Making

Bricks are made and used over much of Pakistan. Both unfired mud bricks, and fired clay bricks are common building materials. The making of unfired, sundried mud bricks is a subject beyond the scope of this work, because mud bricks are usually made as an integral part of the building process and a discussion of building techniques is not relevant here.

The making of fired bricks is relatively standardized in all areas of the country where they are produced. Brickworks are normally operated as commercial-industrial organizations employing skilled workmen for various stages of the process. As is common in most countries, the brickworks are located on the deposit of clay used for making the bricks, to minimize the cost of transporting raw material, and the fuel is brought to the brickworks from suppliers' depots.

The following description of brick making is made from observations at the brickworks of Omar Hayat Khan, on the outskirts of Bannu. The work cycle begins with clay digging (Plate 46). Sufficient clay for one day's work is dug at one time. A skilled molder, working with an assistant, produces between 1000 and 1200 bricks per day. The clay lumps dug from the working face of the pit are broken up on the spot and formed into a hollowed conical pile. Water is poured into the center of this pile, in an amount just sufficient to bring the clay to a stiff plastic condition. The clay is then left for 24 hours to soak. The clay is used without admixture.

The bricks are formed by hand-molding. The assistant carries clay to the skilled molder, who kneads

the clay and prepares cylindrical lumps each of the correct amount of clay for forming one brick. The bricks are molded on the level earth floor of the brick-clay pit.

The molds are made of wood although the molder said that steel molds are coming into use. The standard size of bricks in Bannu is 22.8×11.3×7.6 cm (9×4.5×3 in). Made oversize to allow for shrinkage of the clay during drying and firing, the interior dimensions of molds for a standard brick consist of two parts: an upper section (a rectangular box open at top and bottom) and a lower section (a flat insert which fits into the upper section). The base of the mold has a raised motif, which, on the molded brick, produces a recessed trade mark (Figure 17).

To form a brick the molder places the base of the mold on the ground, places the top of the mold on it, and in the mold places a lump of clay, which his

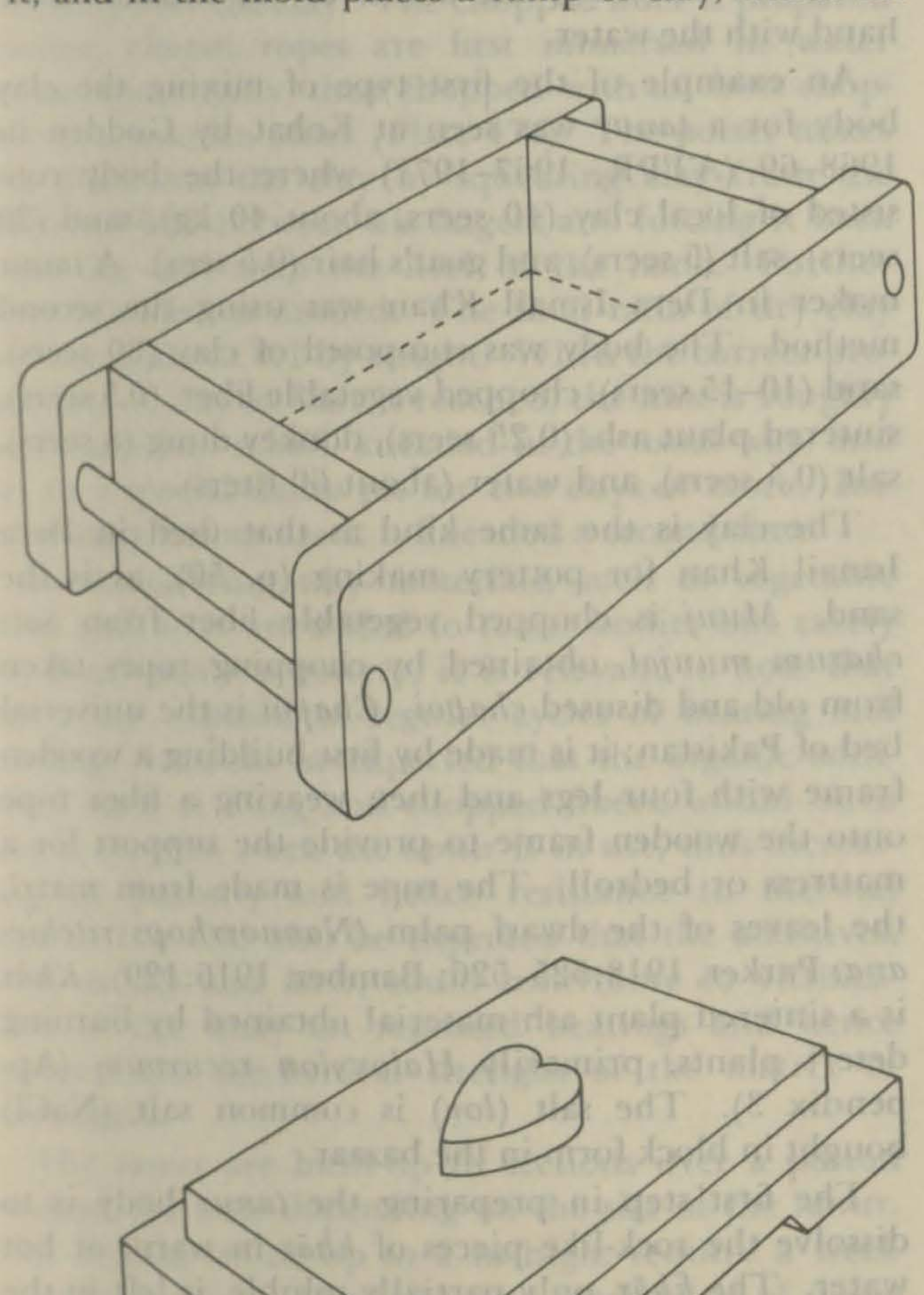


FIGURE 17.—Two-part brick mold as used at Bannu brickyard.

assistant has put on the ground beside him. The lump of clay is pressed into the mold by a number of firm blows with the hand. Excess clay is trimmed off by drawing a tautly held wire across the top of the mold. The mold is then inverted and tapped onto the ground to loosen the freshly molded brick. The base of the mold is lifted off and placed in position for molding the next brick. The top of the mold is removed from around the brick and placed on the base of the mold to continue the cycle. Release from the mold is easy, because the assistant has rolled the lump of stiff-plastic clay on the dry powdery clay floor of the working area before passing it to the molder.

The bricks are allowed to dry flat for 24 hours and are then turned on their edges for another three days in order to dry completely in the hot sun. Then they are loosely stacked, two bricks on edge the thickness of one brick apart and then the next pair transversely across in the same configuration. Bricks from the dry stacks are carried to the kiln by horses or donkeys (Plate 46).

The bricks are fired in a Hoffman-type kiln (Rhodes, 1968:53). This is essentially a continuous trench dug in an oval shape to leave a solid earthen area in the center. Bricks are stacked in an open setting in this trench. The stoker moves the firing progressively around by dropping coal fuel down among the bricks and moving steel chimneys along the setting to provide draft for the area being fired.

The firing progresses continuously around the trench: new stacks of unfired bricks are set ahead of the firing zone and fired bricks are removed behind the firing zone. Bricks in the firing zone are covered with earth so that the draft is regulated according to chimney placement and the standardized open setting pattern for the bricks. This type of brick kiln, originally developed in Germany, is common throughout Pakistan (Rhodes, 1968:53).

In Bannu the fuel is a mixture of coal and wood; the stoker said that coal is the better fuel but some wood is used because it is less expensive than the coal, all of which has to be imported. With mixed coal and wood fuel, the brick color is said to be better than that obtained from coal alone. Thirteen other brickworks in the Bannu region use similar mixtures of wood and coal fuels.

The brickworks produce a range of brick shapes, including half-round, bull-nose, corbels, floor tiles, and other decorative tiles. Shapes based on the standard square brick are formed by placing inserts in the square mold described above.

This brief description applies generally to many brickworks in Pakistan. The only major departure

was observed in Karachi, where refugee workers were producing bricks by similar hand-molding methods, but firing them in a long open pit using dung as fuel. There, the bricks are set in an open pattern and dung placed in the interstices. The fire is started at one end and allowed to burn through to the other, and after cooling all the bricks are removed, and so the cycle continues.

Tanur Making

Tanur are ovens used in Pakistan for baking *nan*, one of the common types of bread and a staple item of the Pakistani diet, particularly in the areas west of the Indus. The *tanur* itself is made in a standardized barrel shape (Plate 47), which varies in size according to the amount of use it receives. A *tanur* for domestic use is usually smaller than one for commercial use, such as in teahouses or by *nan*-sellers who earn their income from baking and selling *nan*. A *tanur* for domestic use is usually of the order of 0.6 m in height and 0.5 m in diameter.

Usually the *tanur* is made by a potter at his workshop, and then transported to a hotel or public eating house and set in place by the potter. If the *tanur* is very large, however, it may be made in situ, the craftsman traveling to the site every two days with the required materials.

When the form is completed and dried, the *tanur* is placed in position and then insulated with a thick coating of mud and straw, applied around the exterior and built into a rectangular shape (Plate 48).

In some cases *tanur* are portable; an example of this may be seen at Sukkur (Plate 47*c*) where the boatmen live beside the river in an area subject to flooding and must move their belongings when flooding threatens. The boatmen also use these portable *tanur* on board the large river boats.

When the *tanur* is to be used (Plate 48), a small wood fire is set inside of it, and when only glowing coals remain, the *nan* can now be cooked. A lump of prepared dough is weighed, flattened, and skillfully placed down into the *tanur* so that it sticks to the side. A number of loaves of *nan* may be cooked at one time depending on the size of the *tanur*. When the loaf is cooked it falls from the side of the *tanur* and is retrieved from the bottom by the baker, using steel tongs. Skilled and experienced bakers remove the *nan* loaf from the side of the *tanur* just before it falls off. The completed loaf is usually about 25 cm diameter and 1 cm thick.

The *tanur* are usually made by potters as a product in addition to their normal range of pottery, but on order only. The production of *tanur* is quite distinct from pottery production in two major aspects: First, the mixture of materials used to produce a *tanur* is quite complex, and organic tempering material is common; whereas, in unglazed pottery making in Pakistan, organic temper is extremely rare and the body is normally composed of one or two materials, such as clay and sand. Second, a *tanur*, is not fired by the maker, but is delivered in unfired condition. The purchaser installs it, and then preheats it with a small fire. It is then further fired in use, each time it is heated, however, the temperature is probably always quite low, in the order of 300°–400°C maximum.

The potters who make *tanur* normally use the same clay as that used for making pottery. The clay is prepared in one of two ways: first, by the methods normally used by potters, that is, crushed, wetted, and kneaded to plastic condition before the temper is added; or secondly, the additives are mixed beforehand with the water.

An example of the first type of mixing the clay body for a *tanur* was seen at Kohat by Godden in 1968–69 (ATPR, 1967–1971) where the body consisted of local clay (40 seers, about 40 kg), sand (20 seers), salt (5 seers), and goat's hair (0.5 seer). A *tanur* maker in Dera Ismail Khan was using the second method. The body was composed of clay (80 seers), sand (10–15 seers), chopped vegetable fiber, (0.5 seers), sintered plant ash, (0.25 seers), donkey dung (8 seers), salt (0.5 seers), and water (about 60 liters).

The clay is the same kind as that used in Dera Ismail Khan for pottery making (p. 50), as is the sand. *Munj* is chopped vegetable fiber from *Saccharum munjal*, obtained by chopping ropes taken from old and disused *chapoi*. *Chapoi* is the universal bed of Pakistan; it is made by first building a wooden frame with four legs and then weaving a fiber rope onto the wooden frame to provide the support for a mattress or bedroll. The rope is made from *mazrī*, the leaves of the dwarf palm (*Nannorrhops ritchieana;* Parker, 1918:525–526; Bamber, 1916:129). *Khār* is a sintered plant ash material obtained by burning desert plants, primarily *Haloxylon recurvum* (Appendix 3). The salt (*loṇ*) is common salt (NaCl) bought in block form in the bazaar.

The first step in preparing the *tanur* body is to dissolve the rock-like pieces of *khār* in warm or hot water. The *khār*, only partially soluble, is left in the water for two or three days. The solid residue is then removed and the remaining solution, known as *khār kā pānī* (water of *khār*), retained.

The clay is then broken up and placed on the ground in a hollowed conical pile, and the *khār kā pānī* poured into the hollow center of the pile. If the amount of *khār kā pānī* is insufficient to bring

the clay to plastic condition then more pure water is added. When the clay is thoroughly moistened the other tempering materials are added, first the sand, donkey dung (*lid*), and fibers (*munj*), and, after some kneading by foot, the crushed salt. The body is ready for use after it is kneaded sufficiently to bring the ingredients to a homogeneous mixture.

Data relating to mixtures used in *tanur* bodies is not available on a wide geographic basis, but all the above compositions contain salt; another mixture reported from Quetta by Godden in his 1968–1970 field notes (ATPR, 1967–1971) also contains *munj*. In Quetta the potters first prepare plastic clay and then mix the *munj* fibers. The clay is prepared by normal Quetta pottery methods (Plate 50) and rolled into balls. Then the balls are roughly flattened with the heel of the hand and the *munj* fiber is sprinkled liberally over the clay. The chopped fiber is prepared earlier; *chapoi* ropes are first immersed in water to wet thoroughly, then chopped with an iron chopper on a wooden block (Plate 47*a*). The potter mixes the fiber into the clay by squeezing clay from the flattened ball between his fingers and forcing it back onto the ball with the heel of the hand. Further fiber is added as needed. The final ratio of dry clay to fiber is about 8:1 by weight. When the correct proportion of clay to fiber is reached, the mix is roughly re-shaped into a ball, kneaded in the usual way, and set in a special damp pit for two days or more. Immediately before use it is kneaded a second time.

In considering why materials, such as vegetable fiber and *khār* are added to *tanur* bodies but rarely to those used for pottery, it is relevant to note that *tanur* are exposed to regular cycles of heating and cooling. It could be expected that the organic additives, such as dung and chopped fibers, would burn out or oxidize when the *tanur* is in use, thus increasing its porosity and hence resistance to thermal shock. It could also be expected that the additives, such as salt and *khār*, could contribute to vitrification of the body on repeated heatings and hence increase the mechanical strength of the matrix of the vessels.

The *tanur* are built-up in sections over a period of days, the time depending on the size of the *tanur*. The largest *tanur*, up to 2 m high, require a week for construction. The following description of *tanur* making is a composite of observations in several locations west of the Indus. The method of construction is similar in all cases.

First, the size of the base of the *tanur* is outlined on the ground, particularly when a large *tanur* is to be constructed. A circle is drawn on the earth with a scriber on the end of a piece of string, the other end of the string is held at a fixed point. The diameter of a *tanur* base is normally about half the final height, but this circle represents the circumference of the *tanur*, rather than its diameter, to the constructor.

The *tanur* itself has no base, only side walls. The potter begins construction by first hand-kneading a lump of clay, which is then placed on the ground and trodden with the feet to a long and narrow rectangular shape. The sides of the rectangle are adjusted for straightness by taking excess clay from some areas and placing it in areas where more clay is needed. The rectangle of clay is then lifted and placed *on edge* around the circle. Excess length is removed, or further clay is added, until a cylinder of low height in relation to its diameter is produced.

When the two ends of the now cylindrical strip are banded together, the rim is thinned slightly by pinching with the fingers. Another slab of clay is formed in the same way as described, and placed on top of the first to double the height of the cylinder. The two rings are bonded together by scraping and smoothing at the joint. If the top rim becomes uneven, further clay is added to make it level.

A draught hole is provided at the base of the wall of the *tanur* to allow air flow over the fuel as it burns when in use. This air hole is cut through the wall of the form with a knife when the lower section is leather hard, at which time it is lifted and wooden blocks placed underneath, so that later the completed *tanur* can be moved easily.

The height of the *tanur* is built up in stages by the process of forming slabs and bonding them to the top of the existing sections. Completed sections must be allowed to dry to leather hard before further sections may be added; otherwise, the lower walls will collapse under the weight. For smaller *tanur* with thinner walls, the drying time may be only a few hours, so that the form can be completed in one day. Larger forms, with diameters up to 1 m and wall thickness of 3–5 cm, dry much more slowly, so that the height may be increased a maximum of about 0.5 m a day.

Conversely, the completed sections of the oven cannot be left drying for too long, because later joints cannot be properly made if the lower section becomes too dry. Drying is speeded up by starting a small fire inside the partially completed oven.

The walls of the *tanur* are smoothed with a paddle and anvil; at Quetta both of these are made of wood. These are also used to shape the top of the oven. While the lower walls are cylindrical, the top of the oven is closed into a roughly hemispherical shape in order to better retain the heat. For closing in the form, the potter first adds the usual cylindrical slab of

clay, but then uses the paddle and anvil to slightly thin the wall, at the same time closing it in at the top by holding the anvil inside the wall at a level slightly lower than the striking point of the paddle on the exterior.

Once the form is completed, the *tanur* is allowed to dry completely before being transported to its permanent site, where it is installed on an insulating mud-and-straw structure. A hole is left in this insulation at the base of the structure; this hole leads to the flue in the base of the wall of the *tanur*, so that air can be inducted for proper burning of the fuel.

Miscellaneous Unglazed Ware

Cooking Pot Stands.—A common product of village potters is the cooking pot stand. Two are shown in Plate 94*a,b*. These are used most commonly with unglazed earthenware cooking pots, although occasionally metal cooking pots are used with them.

The common form of the cooking pot stand is made as a U-shaped slab of clay. The U-shaped stand rests on its side, and three projections at the top provide three points on which the cooking pot can be placed. The cooking fire is built on the ground, enclosed by the U-shaped section. The cooking pot stands are made from the body ordinarily used in workshops for other vessels, not from any specialized composition. The potter builds up the stand by handworking, first forming a slab of clay, then bending it to shape, adding the rests or projections, and then decorating the stand, often with impressed or incised patterns. A red slip may also be applied. The specific shapes and decoration vary in different areas throughout Pakistan, but to date no detailed study of these variations is available.

Foot Scrapers.—Another traditional product of the Pakistani potter is the foot scraper. Two are shown in Plate 49*c,d,e*. This product is a solid slab of clay, with a handle at one end; both sides of the slab have a rough texture. Villagers use the rough surfaces to scrape calluses which have formed on their feet, or to clean mud from their shoes during the rainy weather.

The foot scrapers are made by potters from the same clay body used for their normal range of wares. First, a cylindrical form is thrown on the potter's wheel; a knob forms the topmost part of this solid cylinder. When the cylindrical forms have been allowed to dry to a soft leather-hard stage, the cylinder is flattened, leaving the knob untouched, to produce the final shape. Grain husks, or grains, usually from rice, are then pressed into the two flat sides of the piece. When it is fired the grains or husks burn out, leaving the rough-textured abrasive surfaces. Foot scrapers are undecorated, pigments or slips are not applied and they are always unglazed.

Toys.—A detailed study of ceramic toys has not been made, but it may be noted that many village potters produce miniaturized versions of their ordinary range of wares, such as water jars and cooking pots. These are used by children as toys in playing house.

Field Studies of Glazed Ware

QUETTA, BALUCHISTAN

Quetta, the only locality in Baluchistan to be included in the present work, was not visited personally by Rye; however, the following section is prepared from data in a field observation prepared by Don Godden (pers. comm.), who observed pottery making in Quetta in 1969 and again in 1971. Drawings of a Quetta kiln (Figures 18, 19) and photographs of ceramic production (Plates 50, 51, 52) are from originals by Godden.

Both glazed and unglazed ware are made by the Quetta potter studied by Godden. The unglazed ware is decorated only with incised or impressed bands of decoration on the buff-firing body. The glazed ware, produced from the same body, also normally incorporates narrow bands of impressed decoration. No painted decoration occurs. Only two monochrome glazes are used: brown or green applied over a brown slip.

Materials Gathering and Preparation

The clay is supplied by contractors, who dig it from a special pit at Samungli village some 5 km west of Quetta. It is delivered to the workshops by truck. The landowner (*zamindar*) who owns the pit is paid about 20 percent of the price paid by the potters to the contractors.

There are many areas with suitable clay, but not all landowners allow its removal. The potter sometimes helps with the digging if he is in a hurry, but normally he simply buys clay from the contractors and does not supervise the operation.

The clay seldom has rocks or organic matter in it when dug properly, but often some is introduced by accident during digging and transportation to the workyard. The clay is stored in a corner of the workshop, uncovered until needed.

As the first step in body preparation, the clay, still in this pile, is beaten with a piece of 5 cm steel water pipe or a stout stick about 2 m long to break up the larger lumps. This broken clay is then passed through a sieve with 3-mm apertures. Any pieces that do not pass through are thrown aside.

The amount of body prepared at any one time depends on the demand, sometimes as little as 40 kg (wet clay), or as much as 125 kg.

The sieved clay is prepared as body without any admixture. It is piled in a conical pile, the center is hollowed, and water poured in (Plate 50). The potter judges the amount of water to be added by experience. If he thinks excessive water has been added, some is removed, or if too little, more clay is added to the water.

The clay and water are left to stand for up to an hour. Then the dry edges of the pile are pushed over into the water and, starting at one edge of the pile, very wet clay and some dry clay are squeezed together between the fingers of both hands to thoroughly mix them. The resultant clay, extremely fat and not very well mixed, is made into rough balls weighing about 5–10 kg. These are rolled in dry sieved clay to make them easy to handle, and then are set aside. The process is repeated until the pile of clay is used up.

Balls of clay are kneaded on a clean sheet of iron, to prevent picking up foreign matter. The balls lose some of their moisture during kneading and approach the correct consistency for throwing. They are then taken into the workshop and left for a minimum of two hours before they are used. Ideally, the kneaded balls, covered with a damp cloth that is frequently sprinkled with water, are left for one or two days.

Immediately before throwing, one or more of the balls are again thoroughly kneaded. This second kneading is similar in technique and time taken to the first. If more than one ball is prepared in this way, they are covered with a damp cloth until used. Hand kneading is done in the following steps: The ball of clay is formed to a flattened cylinder, and the cylinder, sitting on its base, is further flattened with the heel of one hand, starting at the center and working back, pressing down and away. Once the lump is flat and stable the heels of both hands are used to form a disc. The far edge of the disc is then lifted and rolled back on itself to form a rough cylinder, this time lying on its side. The cylinder is then spread again with

the heel of one hand, then both, in the same manner, pushing down and away. The disc is folded and flattened this way for several cycles. Then the ends of the rough cylinder, which become quite long, are broken off, placed in the middle, and the whole roughly patted to form a new cylinder. These stages are shown in Plate 50. The kneading process continues until the clay has the correct water content, usually when the sequence after forming the disc shape has been repeated three times.

Forming and Finishing Techniques

It is usual to throw a series of similar articles at one time, the quantity of each depending on demand and stacking of the kiln. Smaller articles, such as oil lamps or small bowls, are thrown directly from a large lump. The large lump is roughly centered on the wheel, then the top of the lump is properly centered and drawn into a cylinder about 5 cm in diameter by 5–7 cm high. The top of this cylinder is further formed to a smaller size, depending on the article, opened, and the vessel formed. The vessel is then cut with string held in the right hand, lifted off with the left hand, and placed on a sheet of steel or wood for initial drying. Large vessels are thrown from a single large lump of clay, the size of the lump being estimated, never weighed.

After allowing the vessels to dry to leather hard for two days to one week, according to the potter, they are turned. The turning tools are simply pieces of sheet metal curved to form a cutting edge.

All articles to be slipped and glazed after turning are allowed to stand in the airing part of the workshop for at least one week and then are placed in the sun for at least two days. They are brought in at night or covered.

Application of Slip and Glaze

All bowls are glazed on the interior; *cilam* (hookahs) are glazed on the exterior and sometimes on the interior; large urns are glazed on both interior and exterior. Smaller vessels, such as oil lamps and water coolers, are not glazed.

Before glazing, all articles to be glazed have a slip applied, which is made from a red mudstone from Sehwan Sharif in Sind. The mudstone is usually crushed and ground and then added to an equal volume of water, although sometimes it is simply roughly broken and then slaked in water. For application, up to 2.5 liters of slip is placed in a large glazed bowl. Slip is first poured into the interior of the vessel to be slipped, which is tilted and rotated to produce a coating on the interior. Excess slip is poured back into the glazed bowl. Slip is applied to the exterior surfaces of some vessels by pouring.

The vessel is set aside and dried for at least a full day in the sun before glaze is applied. It should be noted that the times allowed for drying do not seem to be standard. The vessels drying occurs naturally, almost arbitrarily, in the work cycle. Work progresses from one phase to the next in a fairly rigid cycle, and all questions asked about the time taken for drying between processes had to be considered before an answer was given. Answers were often of the type, "When they are dry," "When they are finished."

Two glazes are used, green and brown in color for which the potter gave the following compositions: Green glaze consists of 8 parts (by weight) ground glass cullet, 4 parts borax, 1 part red lead, and 1 part copper oxide. Brown glaze consists of 8 parts (by weight) ground glass cullet, 4 parts borax, 1 part red lead, and 1 part dry cell manganese.

Glass cullet, usually wastage from cutting window glass or sometimes broken bottles purchased from the bazaar, is ground with a steel mortar and pestle. A sheet of cloth is placed around the pestle and made to cover the mortar to prevent slivers from flying out. The glass is then sieved to remove larger pieces. Borax and red lead are purchased in the bazaar. Copper oxide is purchased in the bazaar if available. If not, the potter prepares it himself by heating a sheet of copper to red heat on a fire and then dropping it into a pot of cold water, whereupon the black fire scale detaches itself. The firescale is then ground with mortar and pestle. This is a long tedious job and avoided if possible.

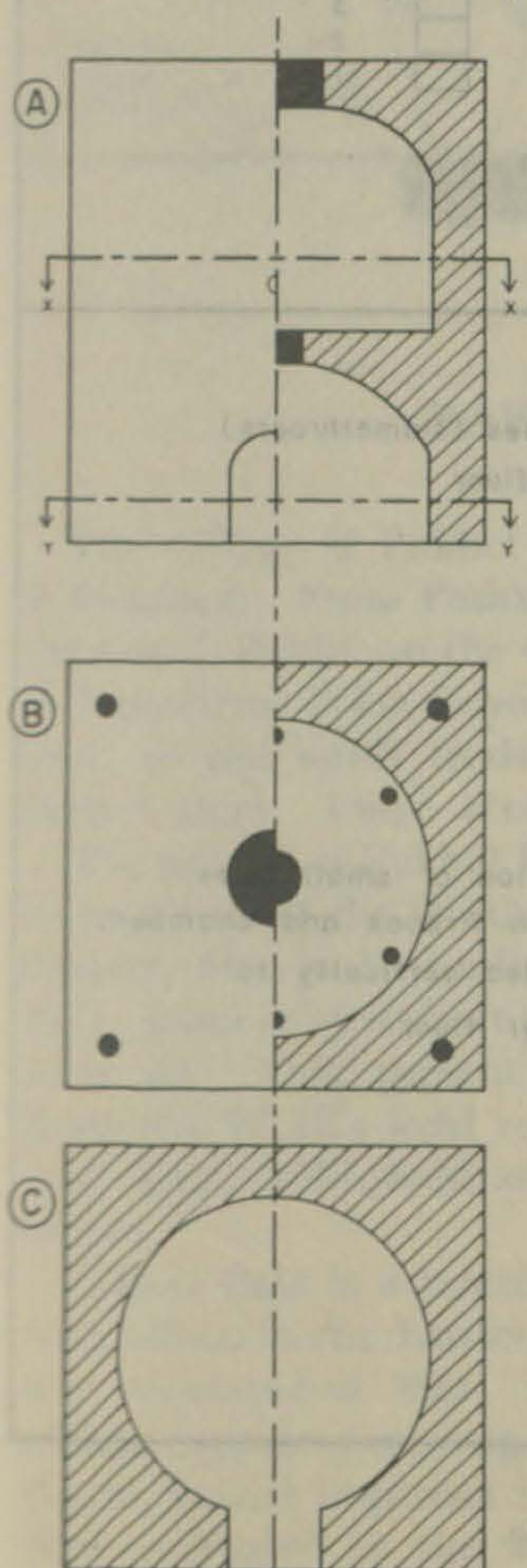
Manganese is derived from the crushed center of dry cell batteries with the cover and carbon removed. Old cells are bought in the bazaar. This material obviously came into use only in recent times after the introduction of such batteries to the area. No information is available to indicate earlier sources of manganese for use as a colorant.

The glazes are not fritted, but mixed and applied raw. To prepare glaze for application, an adhesive carrier is first prepared. Approximately 2 kg of water is brought to a boil in an aluminum pot, 125 g of flour is sprinkled over the water, and the mixture is boiled for 3–4 hours until it becomes thick. Glaze ingredients are added to this carrier and stirred. The glaze is applied to vessels by the same method used for slip (Plate 51), and the glazed pots are stacked in storage until there are enough for one or two firings.

Firing

The kiln used to fire both glazed and unglazed ware at Quetta is an updraft (Figure 18). The method of construction was outlined by the potter, and details are shown in Figure 19. First the firebox is constructed from common brick. The top of the firebox is corbelled to provide a dome, with a central opening left in the dome to act as the main flame throat. Smaller throats are formed as openings leading from the firebox through the brick work around the perimeter of the dome. At this stage the structure is allowed to set for a day and then the space between the dome and cylindrical walls is filled with earth, which is sprinkled with water and lightly rammed around the perimeter.

The outer cylindrical walls are continued vertically, spaces being left for the vertical flues in the outer course. Bricks are laid tangentially to about the tenth course, about the height of a kneeling man. The number of courses is not counted. Bricks are then laid radially and a dome constructed in the same form and manner as for the firebox, with one less course because the opening is larger.



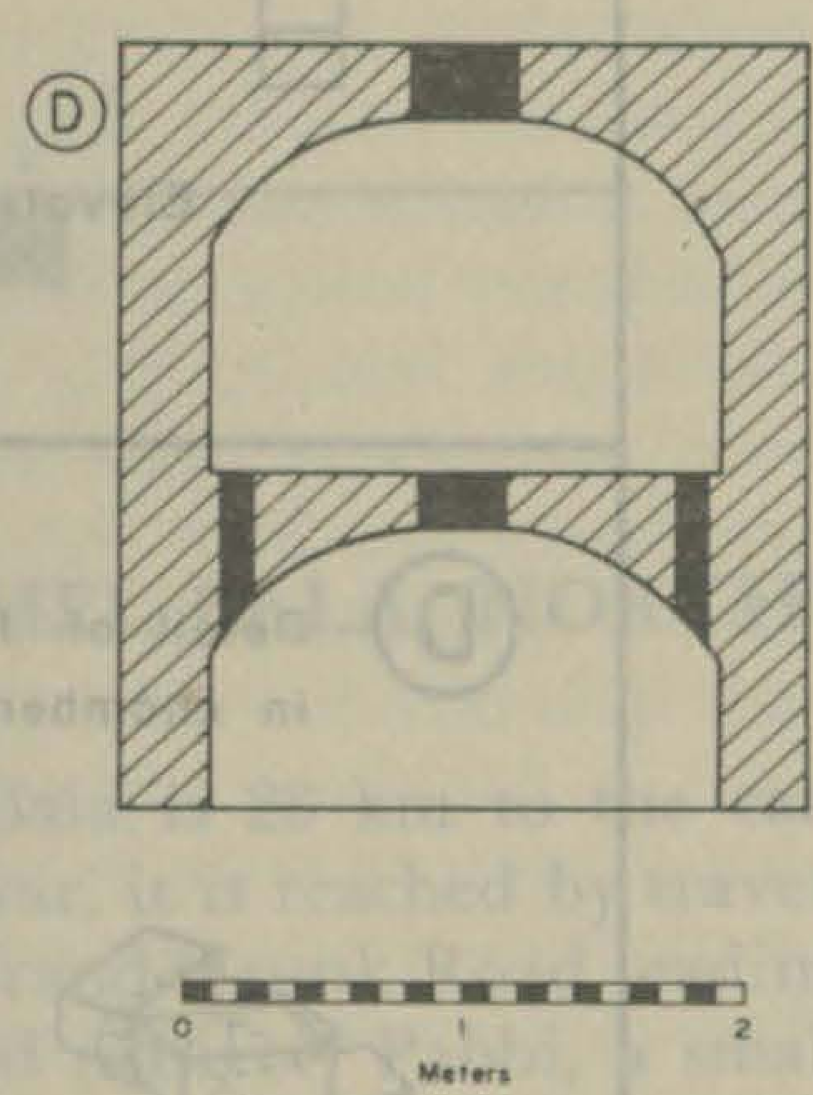


Figure 18.—Updraft kiln at Quetta used for both unglazed and glazed ware: *a*, half-sectional elevation; *b*, half-sectional plan through chamber at position X–X; *c*, sectional plan through firebox and stokehole at position Y–Y; *d*, sectional end elevation. (From original drawings by Don Godden.)

An outside veneer of one brick thick is then built around the kiln and the space between kiln and brick veneer is filled with earth. The kiln is then coated both inside and out with a layer of mud-and-straw plaster about 3 cm thick. Such a kiln takes 15 to 20 man days to build, and lasts 10 to 25 years. The one in use at Quetta is some 20 years old.

The kiln is set from the top with the opening large enough for a man to climb down inside the chamber. First, the vessels are counted and placed on top of, and around the base of, the kiln. The potter then enters the kiln, and vessels are passed down to him (Figure 20, Plate 52). There are approximately 400 pieces in each firing, set in an order that seldom changes because of the conservatism of the range of vessels.

Kiln furniture consists only of rather rough stilts and props (Plate 81). As a result, all glazed vessels after firing are fused to the setters at the point of contact. The glaze usually breaks away when the stilts or props are removed after firing, and it is then usual for the craftsman to paint over the blemish with enamel paints.

Some firings have a majority of glazed vessels; other settings contain all unglazed pieces. There are about 20 glazed firings and about 35 unglazed firings each year, according to the potter.

After setting is complete, the kiln is prepared for firing. A clay-and-straw cover is placed over the top opening of the kiln. The cover is repaired with fresh clay, if necessary. When placed in position the cover is sealed to the top of the kiln by applying a thick coating of soft clay around the junction between the cover and the top of the kiln. The potters also place a clay bung or stopper in the spyhole of the kiln, before starting the fire with kindling wood in the stokehole.

The potters use various types of wood as fuel, preferring a hardwood. In one observed firing the fuel was *babul* (*Acacia arabica*). The type of wood used as fuel depends on which types are available on the market. Fuel consumption per firing is approximately 950 kg when glazed ware is fired, and approximately 700 kg when the kiln contains only unglazed ware.

Kerosene is used to help start the fire. The initial fire, which burns in the stokehole itself rather than in the firebox, has the effects of raising the temperature of the kiln slowly. This initial water-smoking fire is continued for one or two hours, then the fire is pushed progressively into the interior of the firebox over a short period of time. Wood, in large pieces, is used to build up the fire progressively for about 15 hours. After this time, a small bung is removed from

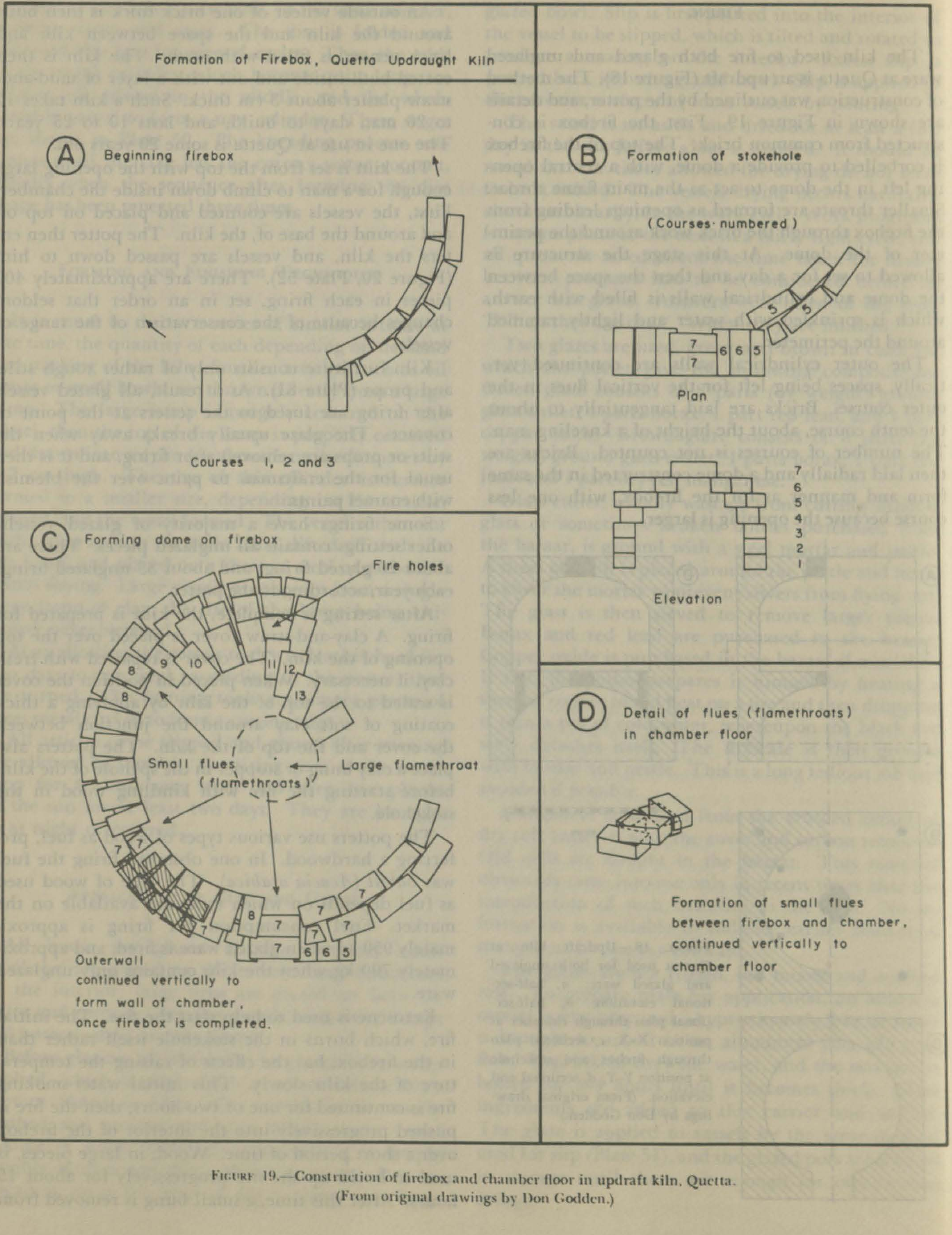


FIGURE 19.—Construction of firebox and chamber floor in updraft kiln, Quetta. (From original drawings by Don Godden.)

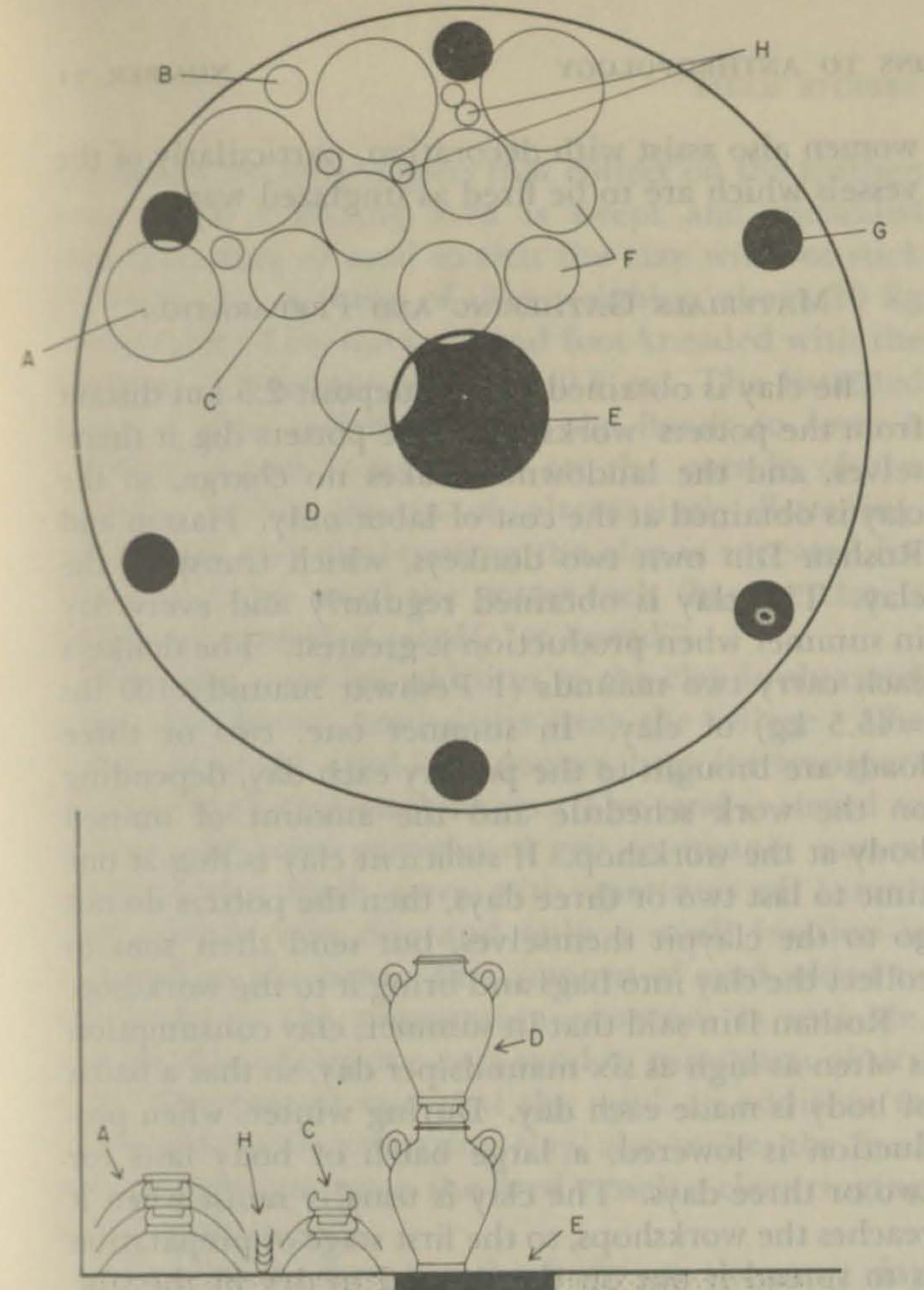


FIGURE 20.—Setting of glazed ware in updraft kiln, Quetta. Stacks continue upward to crown of kiln. (A=large bowls, B=hookahs, C=small bowls, D=large urns, E=central flamethroat in floor of chamber, F=small urns, G=small flamethroats around perimeter of chamber floor, H=small unglazed bowls) (From original drawing by Don Godden.)

the spyhole at the front of the kiln and is not replaced, so that the interior of the kiln can be observed continuously, and stoking varies accordingly. Usually at this time, the glazes are fused and the kiln has reached its maximum temperature. This temperature is then held for, approximately, a further nine hours to complete the heating.

When the firing is judged complete, some of the glowing coals are dragged from the firebox and quenched with water. The mouth of the kiln is sealed with a piece of galvanized iron and mud plastered so the kiln cools slowly. This slow cooling allows about 45 kg of charcoal to form in the firebox. The potter sells this charcoal as a by-product to jewelers, who use it in their forges.

ZAKHEL BALA, NORTHWEST FRONTIER PROVINCE

The village of Zakhel Bala is 28 km to the east of Peshawar. From Peshawar, it is reached by traveling east to Pabbi, on the Grand Trunk Road leading to Nowshera; 2 km beyond (east of) Pabbi, a small track to the south leads directly to the village of Zakhel Bala. Thus, access from Peshawar is easy.

The potters of Zakhel Bala have been visited twice by members of the Smithsonian Ancient Technology Project; first in December 1968, and later in April 1971. Even in that short period of time some changes occurred. This present account is derived from Roswitha Wulff's field report 2 (ATPR, 1967–1971) with Rye's 1971 field observations as the primary source.

Zakhel Bala is a relatively large village compared with others in the district; the total number of houses was estimated at 800. The major industry in the village is pottery making, with an estimated 30 workshops. Initial inquiries in the village indicated that ware produced in the workshop owned by Roshan Din and Hassan Din is among the best in the village, so the observations were made there. Most of the potters in the village are making both glazed and unglazed ware. The glazed ware is very similar to that made in Pabbi, 7 km away, situated on the main road between Peshawar and Rawalpindi. The glazed ware is distributed through large bazaars in Pabbi and two bazaars in Peshawar. Some unglazed ware is bought by the local villagers but most of the production is distributed through the bazaars of Peshawar and Pabbi. From Pabbi, both types of ware are distributed north to Mardan and Dargai, both large bazaars serving both local areas and the markets to the north in tribal territory. The bazaar keepers periodically send trucks to Zakhel Bala to transport the pottery to the larger bazaars, so that the potters rarely accumulate a stockpile of wares. Normally the ware are sold within a few days after firing.

The pottery production is to some extent seasonal. Glazed ware is produced all year round, but the potters work less in winter, especially during periods of inclement weather, when drying vessels is difficult and firing costs increase. Unglazed ware is produced in the summer; production almost ceases in the

winter. This type of ware is fired in open kilns and the danger of vessels being damaged or cracked in firing is much greater during rainy or cold periods.

The potter's craft is hereditary in this village. In the past it had been expected that the sons of a potter would begin, at the age of 7 or 8, to learn from their fathers, and when old enough would become potters themselves. The eldest son would take over the workshop when the father retired or died. In 1971, however, Roshan Din said that social conditions were changing and that he and many other potters felt that their sons should go to school and be educated, and should not become potters if they can find work which has higher social status. In 1968, there had been three brothers working together at his workshop where, as the eldest brother, he was the master potter. But the youngest brother had begun to work also that year as an instructor at a school for potters operated by the government under the Small Industries Corporation. By 1971, this younger brother had begun to work full time as a teacher and was not involved in the workshop at all. Roshan Din felt that the training of young potters would in the future be in schools rather than by the old hereditary system, because the schools taught more modern methods, such as forming by slip-casting. He said that his generation is the last of the traditional potters, not only in his workshop but in many others in the district. He said also that the traditional pottery sales are being threatened by sales of mass-produced chinaware from Guirat and other areas, because the chinaware has higher status than traditional glazed red earthenware. For this reason some of the traditional potters are considering the adoption of newer techniques, such as slip-casting, in order to be more competitive with the chinaware markets.

The workshop of Roshan Din and Hassan Din is combined with their home, but in such a way that visitors to the workshop do not have access to the living area, where *purdah* is observed. The working area is basically an open courtyard about 35 m long and 20 m wide. The entrance gateway is at one narrow end of the courtyard; at the other end is a roof over the courtyard, and under this covered area are the wheels. Drying and firing are done in the open portion of the courtyard. A side door in the covered working area leads to the living area; this door is closed when visitors come to the workshop.

When there are no visitors the women assist with some work in the pottery. The major task of the women is to carry the vessels out into the courtyard for drying, after they are formed on the wheel, and to take them back in for turning or finishing. The women also assist with decoration, particularly of the vessels which are to be fired as unglazed ware.

Materials Gathering and Preparation

The clay is obtained from a deposit 2.5 km distant from the potters' workshop. The potters dig it themselves, and the landowner makes no charge, so the clay is obtained at the cost of labor only. Hassan and Roshan Din own two donkeys, which transport the clay. The clay is obtained regularly and every day in summer when production is greatest. The donkeys each carry two maunds (1 Peshwar maund=100 lbs =45.5 kg) of clay. In summer one, two or three loads are brought to the pottery each day, depending on the work schedule and the amount of unused body at the workshop. If sufficient clay is dug at one time to last two or three days, then the potters do not go to the claypit themselves, but send their sons to collect the clay into bags and bring it to the workshop.

Roshan Din said that in summer, clay consumption is often as high as six maunds per day, so that a batch of body is made each day. During winter, when production is lowered, a large batch of body lasts for two or three days. The clay is usually moist when it reaches the workshops, so the first stage of preparation is to spread it out on the ground to dry in the sun. The larger lumps are broken up with a stick so that the largest remaining pieces are about 3–4 cm diameter. Waste clay from the workshop is thrown onto the pile of new clay. When the clay dries it is beaten with a stick again to reduce the lumps to a smaller size. It is then sieved through a very coarse sieve made from a flat-based copper dish by punching closely spaced holes in the bottom of the dish. The diameter of the holes in the bottom of the dish average 1 cm. The clay is sieved onto one spot so that a conical pile is formed; this is then hollowed in the center, and water poured into the hollow. The water is obtained from a well located in the potter's courtyard; water from the same well is also used in the home for drinking and washing (Plate 61*c*). Clay from the edges of the pile are moved to the center so that all the clay is moistened evenly. In this form the clay is described as *khāta*. When the clay is evenly moistened and left for some hours it is gathered in lumps each weighing about 15 to 20 kg, and carried to the covered area of the workshop. The lumps are stacked in one corner where they are covered with wet sacks to keep the clay moist until it is kneaded.

The clay is not kneaded until just before it is used for forming vessels. An area about 1 m^2 of the covered workshop floor is reserved for the initial kneading, so that the clay will not become con-

taminated by stray objects that collect on the earthen floor. The kneading area is swept and sprinkled with a coating of sand so that the clay will not stick to the floor. A lump of clay weighing about 20 kg is then placed on the sand and foot-kneaded with the heels to a diameter of about 0.6 m. The flattened lump is then rolled up with the hands to form a cylinder. Sand is sprinkled on the outside of the cylinder. This process of alternatively flattening, rolling up, and sand-coating the clay is repeated for 10 to 20 cycles, until the potter feels that the clay is adequately kneaded (*a<u>kh</u>āl*, "to knead").

The sand used for addition to the clay is obtained from wind-blown sand drifts near the village. The potters load the sand into donkey bags for transport to their workshop on donkeys. The sand is sieved to remove any large particles of grit or organic matter, using a wire mesh sieve with apertures of 1 mm. The sand is very fine and only a small fraction is retained on the sieve. The amount of sand added to the body by the preparation processes is variable, estimated at about one part sand to nine parts of dry clay. The potters said that the sand, in addition to its benefits while preparing clay, also makes the fired pots stronger and gives the fired vessels a clear ringing sound when tapped.

The potters often use the body on the same day that it is prepared, although they prefer to leave it for at least 24 hours before use, as this seasoning slightly improves its working properties on the wheel.

Before using clay for forming vessels on the wheel, the potters again knead it, this time with their hands. A smaller lump is used, weighing from 2–7 kg, depending on the size of vessel for which the clay is intended. For this kneading the potter sits at the wheel. He sprinkles some cow dung ash obtained as residue from kiln firings, or wood ash from the glazed ware kiln, onto a stone slab set into the ground beside each wheel. This ash is said to soften the clay slightly during kneading, and also to strengthen vessels after firing, but its major purpose is to stop the clay from sticking to the stone slab during kneading. The lump of clay is kneaded by rolling it to a cylinder beneath both hands and then flattening the cylinder with the heels of the hands, rolling it back to a cylindrical form again and repeating this sequence.

Forming Techniques

All vessels made at the Din brother's workshop are initially formed on the potter's wheel. The wheels are typical of Northwest Frontier Province pit-wheels, set in a pit excavated in the floor of the workshop. The wheelhead shaft (*<u>gh</u>ashay*), top wooden cross-member, and flywheel (*pal*) are all made of wood. The flywheel, averages 48.5 cm in diameter and 10 cm thick and is made from *<u>sh</u>ī<u>sh</u>am* (*Dalbergia sissoo*) wood. Its weight is estimated at 15 kg. The wheels are modified from the traditional construction by having the bottom bearing replaced by a ball bearing taken from a truck axle. The wheelhead fitting also is modified, so that a recessed nut on the head is screwed onto a threaded steel stud set into the top of the wooden shaft. The potters claim that these modifications give the wheel greater momentum than is obtained from the traditional design, provided that the bottom bearing is regularly greased.

A large range of vessel types is produced at this pottery, so a variety of forming techniques is used. Vessels fired as unglazed red earthenware are formed by methods that have been described elsewhere (pp. 35–36). The cooking pot (Plate 66*c*) and lid are formed by the same methods used by Khan Zada of Dir; the water pot (Plate 66*a*) is formed by the techniques used by Abdul Janab in the nearby village of Musazi, using molds as shown in Plate 67. The *kūzā* (Plate 66*b*) is formed by methods similar to those used for the cooking pot, that is, placing a dish-shaped mold on a cloth pad on the wheelhead, forming the base of the pot as a flat disc of clay which was placed in the mold, adding a coil of clay to the periphery of the base, and throwing that coil of clay to form the upper walls and neck of the vessel. The spout is thrown at the same time and joined afterwards. The paddle and anvil technique is not used at the Zakhel Bala pottery; and pots formed on the wheel in a base-mold are complete at the base when removed from the mold.

All of the vessels to be glazed are thrown from a lump of clay placed directly on the wooden wheelhead; some small unglazed vessels, such as small dishes, are also formed this way. To form these small dishes, the potter hand-kneads about 6 kg of body, rolls this into a lump and places it on the wheelhead. He roughly centers the lump, while the wheel slowly revolves. He then centers a small amount of clay at the top of the lump and from this throws a small dish. He then forms a shallow groove below the base of the dish, using his fingernail as a tool. The end of a piece of string is then touched to this groove and, as the wheel revolves, it carries the string around the base of the dish. When the string travels completely around the base, the dish is cut off from the larger lump of clay by pulling the free end of the string. The dish is lifted off, while the wheel is still revolving, and placed on the ground beside the wheel, to be carried outside for drying by an assistant when sufficient dishes are accumulated. The method of

cutting off the bowl leaves a distinctive spiral pattern on the base. These small dishes are not turned afterwards, but dried and coated with red slip. Throwing each one takes only ten seconds and Roshan Din said that if his assistants work all day he can throw three thousand dishes daily.

One of the main products of the workshop is the hookah. These are made in several forms, but the basic form is a bottle shape, which is sold either unglazed or glazed. This shape is also thrown from the hump (Plate 55). The thrown vessels, of which 150 per day can be formed, are carried out into the open courtyard and left to dry to leather hard. The base of the vessel is then turned with a sheetmetal turning tool (*cilnī;* Plate 58*a,b*). This evens the thickness at the base and also forms a foot-ring on which the vessel stands. These vessels are turned in a chuck made of fired clay. First, the potter forms a disc of soft clay on the wheelhead; then he places the chuck, a simple open cylinder, on this soft clay and centers the chuck. When it is revolving smoothly he stops the wheel and pushes the chuck down into the soft clay, which holds the chuck firmly in place. He then places a coil of clay around the rim of the cylindrical chuck, and fixes it in place by smearing the edges of the coil onto the side of the chuck. The vessel to be turned is then placed upside down on the chuck, with its shoulder resting on the coil of clay on the rim of the chuck. The vessel is supported with the left hand; the turning tool being held in the right hand. Trimmings and clay waste from these forming operations are taken outside each day and thrown onto the pile of new clay for recycling.

Another major product of the pottery are bowls (Plate 68). These are sold glazed and made in three sizes with diameters of 36, 24, and 20 cm. These bowls are thrown from a hump, using a profile tool to shape the inside of the bowl. This profile tool is a rim sherd from a broken vessel. After throwing, the bowls are taken outside and dried to leather hard. They are then turned. For turning, a soft clay chuck is used. The potter places a lump of clay on the wheelhead and centers it as he would for throwing; the bowl to be turned is then placed upside down on the lump of clay and pressed down firmly to hold it in place. The sequence of thinning the lower walls of a bowl and forming a foot-ring is shown in Plate 58. When turning is complete the bowls are stacked outside to dry.

The potters also make vessels of the type known locally as "Peshawar Ware," referring to vessels with pierced decoration and colored lead glazes. One such vessel is a large hookah with double walls. Roshan Din showed how these are formed, and said that he considers this to be the finest product of the workshop (Plates 56, 57).

The first stage in making this vessel is to throw two open forms, which are allowed to dry to leather hard. While the vessels are drying, the potter places a lump of clay on the wheelhead and flattens it out to form a disc of soft clay. By the time that the two parts of the vessel are leather hard, this disc of clay has stiffened slightly and can be turned with a turning tool. A recess is formed, into which the flared top of the larger of the two initial forms fits accurately when placed upside down on the chuck. The larger of the two forms is then placed upside down in this recessed chuck, supported in place by a coil of clay pressed onto the wheelhead around the outside of the vessel and chuck. The outer walls of the vessel are turned, and the original base cut out completely and discarded, leaving this section as a vessel open at both ends. The second form is then fitted down inside the first and joined in this position by bonding a coil of clay around the junction of the two forms and throwing the soft clay to a smooth shape. Excess clay at the top of the smaller, or inner, vessel is then cut away and discarded. The result is a double-walled vessel. The potter then bonds a coil of clay to the rim of this vessel and shapes it to form the neck of the hookah. The final shape is similar to that of the smaller hookahs previously described (pp. 79–80), but this larger version is double-walled, so that water placed in the hookah is contained only by the inner section. The outer wall is decorated by piercing and by removing sections to form a geometric design. In order to complete this decoration the vessel is placed back on the wheel, this time resting on a fired clay chuck. The potter then uses a sharp pointed steel knife to cut away sections from the outer wall. The completed vessel is shown in Plate 56*a*. It should be noted that the neck of the vessel also is carved decoration; but because the neck has only a single wall, the carving is in relief only, unlike the perforated pattern on the lower walls of the vessel.

Small plates with perforated decoration around the rim are also made at this workshop. The plates are thrown and turned in the same way as the bowls, and then sections are cut from the rim to form a geometric design (Plate 58*h*). These plates are only sold as glazed ware.

DECORATION

Several types of decoration have already been outlined. For unglazed vessels these include the relief decoration on molded water pots, and for glazed vessels the carved and perforated decoration applied to hookahs and plates.

For unglazed vessels the final decoration is red slip, sometimes with black pigment brushwork applied over the slip. The potters follow the usual Northwest Frontier Province practice of applying red slip by wiping the slip onto vessels with a cloth. For application by this method the slip is prepared to a very watery consistency. On some vessels, for example the *kūzā*, the slip is applied as an overall coating. Red slip also is commonly applied as a partial coating, as on the upper part only of the molded *mangay*. Another style is the placement of bands of slip around the upper walls of the molded vessel with bands of black pigment to accentuate the bands of slip (Plate 59*a,b*). The black pigment is obtained from traders, who bring the black stone from the mountains of Dir. It is prepared by crushing the black stone with a river pebble used as a hammer, and then grinding to a fine powder on a flat stone, again using the river pebble for grinding. This same pigment is also used with glazed ware to give a brown color under the lead glazes.

The glazed ware is decorated when bone dry and before firing. Glaze is applied after the decoration is completely dry. The decorative materials are a white slip, a blue from cobalt, brown from manganese, and green from copper pigments. The white slip is derived from a white clay. In 1968, the potters were obtaining a white clay from Khairabad Kund, about 60 km from Peshawar, the traditional source of white-slip clay. By 1971, they were using a different material, a white clay obtained from potter's suppliers in Gujrat, which was easier to obtain than the traditional material. The potters said that the fired appearance of the two materials is identical. The white clay from Gujrat is also used as a fireclay for kiln repairs. To prepare the white slip (*astar*) the potters slake the white clay in water in an iron dish, and stir the slip until all lumps are broken down. The slip is applied by pouring it over the vessels. A yellow slip is also used; the potters did not disclose details of this beyond showing a black powder and saying that this is added to the white slip. They also said that if the black powder is added to a clear lead glaze in the proportion of one sixteenth part of black powder to four parts frit, then a yellow glaze results. Although a sample of the black powder, which produces a yellow color, could not be obtained, it can be said with some certainty that the black powder is an oxide of antimony. This oxide is available in most bazaars in the Northwest Frontier Province, and is widely used as personal adornment by both men and women to blacken eyelashes. It is also applied to the skin around the eyes as a black eyeshadow.

The brown pigment is the same material as that used on unglazed ware, on which it gives a black color (above). The blue pigment is cobalt oxide obtained from potter's suppliers in Gujrat. The green pigment is a black copper oxide, bought as copper scale from coppersmiths in the Peshawar bazaars. All three of these pigment materials are prepared by grinding finely with a round stone on a flat piece of slate. The copper oxide is further refined by sieving through a cotton cloth after grinding. For application, the pigments are mixed with water in a small bowl and applied with a brush made from donkey mane, bound to a wooden handle with cotton thread.

Glaze making will be discussed in detail, but it is necessary to note here that three glazes are in use: a clear lead glaze, a transparent green glaze, and a yellow glaze.

The order of application of the decorating materials is always slip first, then pigment brushwork, then glaze applied over slips and/or pigment. The combinations of decorating materials which were commonly used are shown in Table 2.

The table shows the usual combination of decorative materials on glazed ware made by the potters of Zakhel Bala, and also by the potters of Pabbi, 7 km away. Typical design patterns are shown in Plates 68 and 69.

TABLE 2.—*Classification of decorative combinations on glazed ware from Zakhel Bala, NWFP. All the glazed wares are of the same clay body and are fired in the same manner*

SLIP		PIGMENT	GLAZE	
Overall coating	Brushwork patterns	Brushwork	Brushwork	Overall coating
-	-	-	-	Green
-	White	-	-	Green
-	Yellow	-	-	Clear
-	White	Brown	Green	Clear
Yellow	-	Brown	Green	Clear
White	-	Green	-	Clear
White	-	Green and brown	-	Clear
White	-	Blue and brown	Green	Clear

GLAZING

Only one type of glaze, lead based, is used in Zakhel Bala and Pabbi. The glazes are prepared in three basic stages. Raw material for the first stage is metallic lead, brought from scrap metal dealers in a bazaar in Peshawar. The lead (*sikka*) is placed in a crucible made from an ordinary pottery body. The crucible is permanently fixed in a roasting furnace (*dasht;*

Plate 60*a,b*), that is the crucible is set into the furnace. If the crucible becomes damaged, it is necessary to remove the stone-and-mud top of the furnace to remove it, and to rebuild the top of the furnace after installing a new crucible. The furnace is built completely above ground level, from scrap brick and stone, which are bonded with mud-clay mortar. At the bottom is an open chamber where the wood fuel is burned; above this the crucible rests on stones projecting from the side of the chamber. At the top of the furnace, a hole allows access to the lead-containing crucible, and another small hole acts as a flue when the main top hole is blocked off by stirring or removal operations. While the lead is being roasted it is stirred with an iron rod (*sikh*) with an iron disc attached to the stirring end (Plate 60*a*). As the oxide forms on top of the molten lead it is removed with an iron ladle and placed into an iron dish (*baltay*). The actual roasting of lead was not observed but was described by Hassan Din, who said that the powder removed from the crucible is an orange-green color.

Potters in Pabbi do not use this first stage of the glaze preparation process. Instead they purchase red lead oxide from suppliers. Otherwise glaze preparation in Pabbi is as described here for Zakhel Bala.

The lead oxide is a major glaze ingredient. The other is quartz in the form of a friable sandstone. Examination of the sandstone with a hand lens shows that the rock consists primarily of quartz grains ranging in size from 1–3 mm, with a fine-grained matrix of unknown composition. The matrix is present in insufficient quantity to bond the quartz grains together, and the rock is so friable that it can be crushed to individual grains in the hand. The rock is mined by the potters at an unspecified locality near the village. It is prepared by crushing on a slate slab, using a hard rounded stone as both hammer and pestle.

The crushed stone and the lead oxide are mixed together in an iron dish. According to Roshan Din, the ingredients are weighed separately in the proportions 12 parts by weight of lead oxide to 3 parts by weight of quartz sandstone. From the 1968 field session, Roswitha Wulff (ATPR, 1967–1971, report 2) reported these proportions as 10 parts of lead oxide to 3 parts of quartz, so it is possible that exact proportions are not strictly observed.

When fused, these two materials form a clear glass frit, which is crushed and used as a glaze. Apart from the clear glaze the potters use two others: a green glaze and also a yellow. These two colored glazes are produced by adding oxides to the lead oxide-sandstone mixture before fusion. For the green glaze, copper oxide is added. The potters use the same black copper oxide, or copper scale, that is prepared for use as a pigment for brushwork decoration. The amount of copper oxide added to the lead oxide-sandstone mixture was not specified by the potters, but examination of fired vessels at the workshop showed considerable variations in the green color of the fired glaze, indicating that the copper oxide addition varies from batch to batch.

The yellow glaze composition was not specified, but, as for the yellow slip mentioned above, it may be reasonably assumed that the colorant is antimony oxide, which is easily available in the bazaars, and which gives a yellow color in the presence of lead, in glazes. The potters described the colorant simply as a yellow color and said that the amount added to the lead oxide-sandstone mixture is one part of yellow color to 64 parts of lead oxide-sandstone, by weight.

The three basic glaze mixtures are lead oxide and sandstone; lead oxide, sandstone and copper oxide; or lead oxide, sandstone, and antimony oxide. The mixture is stirred thoroughly by hand in each case, to blend the materials, and is then transferred from the iron mixing dish to a crucible. This crucible is permanently set into a frit furnace (Plate 60*c,d*). The frit furnace is similar in construction and size to the lead roasting furnace previously described, but modified slightly by having a large opening, about 0.2 m diameter, in the front wall. This opening provides access to the crucible for removal of molten frit. The furnace is heated with wood, which is inserted through a stokehole at one side near the base of the structure. An access hole at the top of the furnace is sealed with a circular slab of fired clay while the frit is being fused. The fritting temperature is not known as the potters did not make any frit while the field study was in progress; but the potters said that the furnace is heated for four hours before the molten frit is removed. This is done by scooping frit from the crucible with an iron ladle and pouring the fluid frit into cold water in an iron dish (Plate 60*c*). This cools the frit very quickly, and the quenching action breaks up the solidifying frit into small pieces which can be ground easily. The frit (*rang*, literally, "color"), after cooling, is crushed first with a stone to break up any large fragments, and then the water is poured off and the iron dish containing the frit left in the sun to dry off the remaining water by evaporation. The frit is then ground to a fine powder in a quern (Plate 60*e,f*), with two stone grinding wheels, each 0.5 m in diameter.

The glaze is applied to completely dry, decorated vessels. For application, the glaze powder is placed in an iron dish, and water is added. The glaze is then stirred to place the powder in suspension. The

glaze is applied to vessels by pouring. Glaze, and previously the slip, are applied only to the exterior of upright vessels and to the interior of bowls. The glaze solution is constantly stirred to keep the glaze powder in suspension while glaze is being applied to vessels. The glazed vessels are then set aside in the pottery courtyard to dry again before firing. When not in use the glaze material is stored in the iron dish in a damp area of the workshop, and allowed to dry out slightly, although it is always kept moist. The potters simply add extra water each time the glaze is used.

Normal workshop practice is to build up a stock of vessels to be slipped and glazed, until there are 2000–3000. With someone assisting by carrying vessels to and fro, the potters can apply slip to all of these in one day. After allowing them to dry overnight they can apply the glaze to all of them the next day. Usually this provides more than enough vessels for one firing, depending on the size of the vessels.

Firing

The glazed ware is fired in an updraft kiln of simple design. Four outer walls form a square. Within this, a cylindrical wall defines the shape of the interior of the kiln; a floor divides the interior into the firebox below the floor and the chamber above. One of the kilns is shown in Plate 61 and in Figure 21.

During the course of field investigations in 1971, the potters were asked how the floor of the kiln had been constructed, as it appeared flat both on the top and bottom and, as such, could not be self-supporting if constructed from bricks. The potters agreed to construct another kiln up to floor level in order to clearly show the methods of kiln-building for glazed pottery.

The kiln built for this demonstration is somewhat smaller than the two kilns in use at the pottery, but the structure is identical proportionally to the larger kilns, with only one departure from normal practice. Normally, kilns are built with a fired-brick inner wall and a stone outer wall, both of these bonded with a mud or clay mortar. The demonstration kiln is built completely from brick purchased by the investigators. Stone is normally used on the outer wall for economic reasons; that is, it is obtained free of charge, whereas bricks have to be purchased from bricksellers. The potters feel that brick is a better material than stone for kiln building, because bricks can be laid with even jointing and thus resist cracking due to expansion and contraction.

The first stage in buliding a kiln is to select a

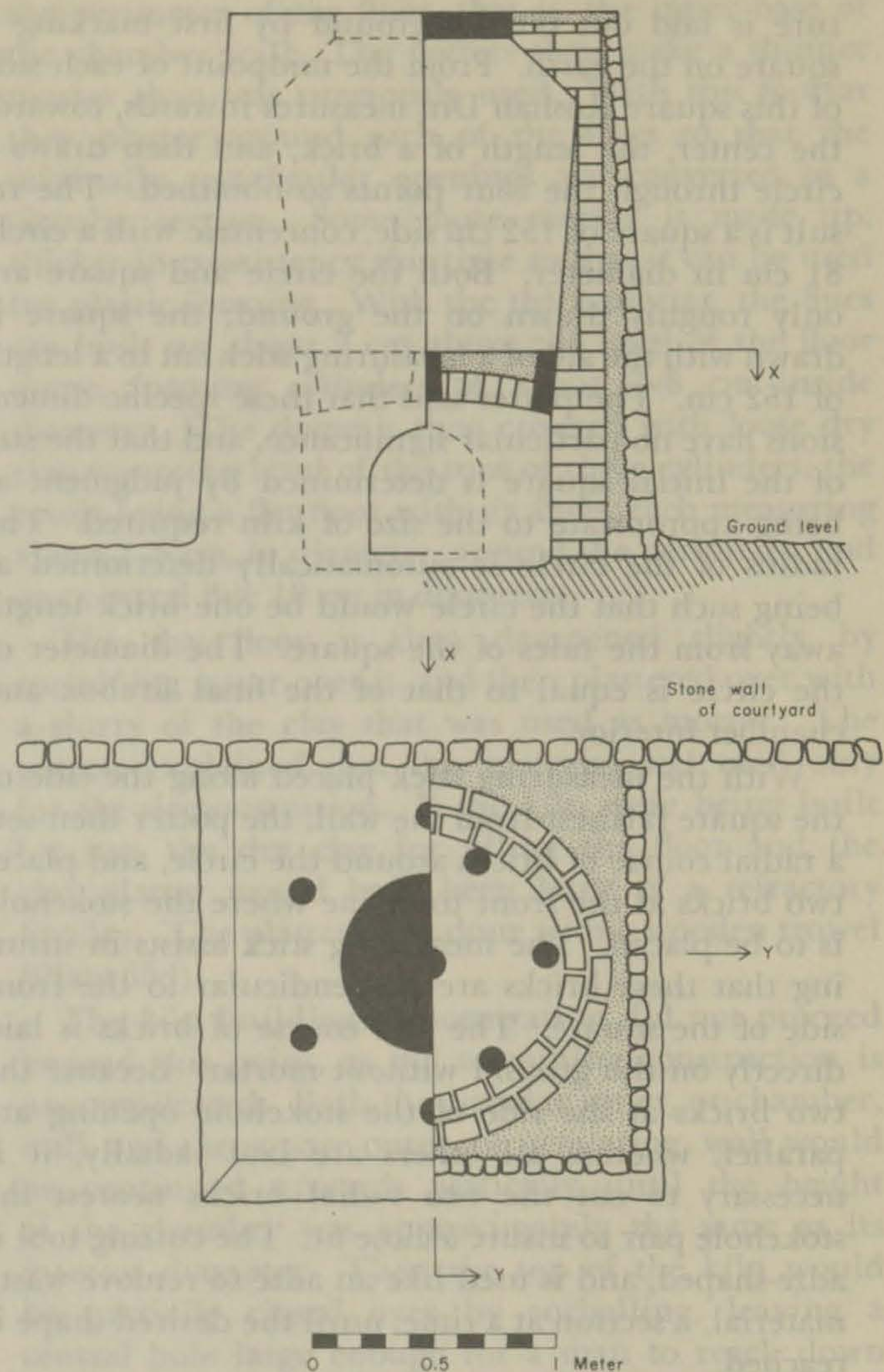


FIGURE 21.—Updraft kiln, Zakhel Bala, NWFP: *top,* half-sectional elevation; *below,* half-sectional plan. (black=flues, flame-throats; stippled=clay/mud fill.)

suitable site where the kiln will be sheltered from winds that would interfere with the draft, and as close as possible to the workshop to reduce the distance pots have to be carried. Normally, a site in the corner of the courtyard is selected, so that the stone wall of the courtyard is utilized as two of the outer walls of the kiln and thus saves on labor and materials.

Since the only two suitable corners of the courtyard were already occupied by the two kilns in use, the demonstration kiln was built against one long wall of the courtyard. The surface of the ground sloped from the wall downwards to the center of the courtyard, but no attempt was made to level this area before the construction began. The sequence of steps in building the kiln is shown in detail in Plates 62–65. The outside diameter of the cylindrical struc-

ture is laid out on the ground by first marking a square on the earth. From the midpoint of each side of this square Roshan Din measures inwards, towards the center, the length of a brick, and then draws a circle through the four points so obtained. The result is a square of 152 cm side, concentric with a circle 81 cm in diameter. Both the circle and square are only roughly drawn on the ground; the square is drawn with the aid of a measuring stick cut to a length of 152 cm. The potter said that these specific dimensions have no particular significance, and that the size of the initial square is determined by judgment as being appropriate to the size of kiln required. The radius of the circle is automatically determined as being such that the circle would be one brick length away from the sides of the square. The diameter of the circle is equal to that of the final firebox and chamber interior.

With the measuring stick placed along the side of the square farthest from the wall, the potter then sets a radial course of bricks around the circle, and places two bricks at the front to define where the stokehole is to be placed. The measuring stick assists in insuring that these bricks are perpendicular to the front side of the square. The first course of bricks is laid directly on the ground without mortar. Because the two bricks at the side of the stokehole opening are parallel, whereas all others are laid radially, it is necessary to cut the two radial bricks nearest the stokehole pair to insure a close fit. The cutting tool is adze-shaped, and is used like an adze to remove waste material, a section at a time, until the desired shape is reached.

When the first course is laid in place, defining the basic shape of the structure, the potter mixes some mortar. This is the clay and mud used in the village for building mud walls, houses, courtyards, etc. The mortar is mixed in a large dish, adding water to the mud and stirring by hand until the correct consistency is achieved, with no attempt to remove any but the largest (bigger than about 1 cm) lumps of grit. More mortar is mixed by assistants at later stages, as it is required. About ten friends of the potters, most of them also potters, came along to assist and discuss the kiln-building. They said they were interested because kiln building is a rare event, since some kilns last up to fifty years if kept in good repair.

A second course of bricks is then laid with mortar, this time as stretchers in a circumferential course. The mortar is spread on the existing brickwork to a thickness of 1–2 cm, and then the bricks are pressed down into the soft mortar by hand pressure only. The mortar is spread by hand; no trowels or other tools are used. Mortar is packed into any gaps existing when the complete course of bricks is laid. Another course of bricks is then laid on the ground, outside the circle, to define the shape of the outer insulating, square wall of the kiln. Then the section at the front, which is to form the sides of the stokehole, is built up as two columns, each two bricks wide and two and a half bricks from front to back. The stokehole is completed by corbelling, with half-brick overlaps. The corbelled bricks are cut to shape so that the top of the stokehole is rounded. Roshan Din said that if the kiln were larger, the stokehole would be closed over with an arch, but as this kiln is small the structure will be sufficiently strong with the corbelled arch, which is simpler and easier to construct. The stokehole is completed in seven courses of brickwork.

The potters then begin to lay additional courses of bricks around the firebox area. This circular structure is built with radial courses from the third course of bricks upwards. Joints are broken on each course; that is, each brick is laid across the gap between two bricks on the course below. The potter said that the radial courses form a better circle than would stretcher courses. The bricks are not bonded tightly by mortar, many gaps are left in the joints. These gaps afterwards are filled with loosely packed clay.

When the cylindrical structure is completed up to the fifth or sixth course, the potters begin to construct the square outer wall. This is only one brick thick. As it is built upward, the gap between the inner circular structure and the outer square wall is filled with dry clay. The clay is broken up roughly with the back of a shovel, shoveled in, and packed down loosely. The clay acts as a layer of insulation when the kiln is fired, and because the clay is loosely packed it tends to seal over any cracks in the structure and prevent localized drafts.

The outer and inner walls are then both finished up to the level of the eighth course of brickwork, and the gap between the walls is filled with dry clay and levelled off. At no stage is there any measurement of levels, and the structure is kept only approximately level by the builder's judgment. In fact, one side of the outer wall, which begins on a level slightly lower than the other, is one course higher than the other by this stage, i.e., eight courses versus nine. This lack of level in the structure is considered by the builders to be quite acceptable. They said that their only concern is that the kiln be a stable structure, and that in their opinion it is.

After the above stages are completed, the chamber floor is constructed. A formwork is constructed to support the floor during its construction. In this case

the potters use a steel drum to carry the formwork, but they said that in the past a column of bricks was used. The drum is simply more convenient. They first check that it fits through the stokehole as it later has to be removed that way.

The drum is placed in the center of the firebox and adjusted so that the top is level with the top of the brickwork, by inserting wedges of wood underneath. The main formwork is then constructed from pieces of timber. Pieces of timber are pushed into gaps in the brickwork below the upper course, with the other end resting on the drum. The gaps between these pieces of timber are then covered by placing further pieces of timber across them. Finally, the smallest gaps are covered with potsherds. Then this formwork is covered with loose dry clay, up to the level of the top of the brickwork. This clay itself is part of the formwork; it is piled about 7 cm higher at the center than at the edges, to give the form for a low dome. A further radial course of bricks is then laid directly on the circular structure of the firebox, to give a course above the clay form. The only task remaining before beginning construction of the actual floor is setting the positions of the flues which will connect the firebox below with the chamber to be built above. Bricks are used as templates for this. These bricks are moved around until six equally spaced areas are laid out. The positions of these six points are marked with small lumps of clay placed around the perimeter of the floor area. The template bricks are then removed.

A circular pitched course of brick is then laid around the interior of the radial course. This pitched course is not vertical; individual bricks slope outwards at the top. Gaps are left where the flues will later be formed. Further courses are laid inside this, each circular and correspondingly smaller in diameter as work proceeds towards the center of the floor structure. Because of the rise of the formwork towards the center, this floor structure is in the form of a low dome. Large gaps, up to 2 cm wide, are left between bricks, but filled with mortar. The potters explained that when the kiln is later fired and the clay mortar undergoes firing shrinkage, the floor dome will settle slightly in the center. It is possible such a structure, if the bricks are set with very fine gaps, will expand sufficiently on heating to damage the side walls. The large gaps used in practice, combined with the shrinkage of the clay mortar, tend to eliminate this danger in a structure with no external bracing.

A hole about 10 cm diameter is left in the center of the floor dome. When the dome is completed, a further course of bricks is placed in position around the perimeter of the floor, that is, the inner base of the chamber wall. The potters then make a thinner mortar than was previously used. With this mortar they plaster around each of the flues so that the originally rectangular openings are converted to a circular section. Some more mortar is made up, thicker in consistency this time so that it can be used for plastic forming. With the thick mortar, the flues are built up about 7 cm above the level of the floor dome, forming cylinders of about 7–8 cm inside diameter. The dome is then covered with loose dry clay up to the level of the tops of these cylinders, the result being a flat floor with six flues, each measuring about 7–8 cm, in diameter, around the perimeter, and one central flue 10 cm in diameter.

The dry floor is then dampened slightly by sprinkling water over it, and then plastered over with a slurry of the clay that was used as mortar. The potters explained that this material was used only for the demonstration. If the kiln were being built for use, the dry clay for filling the floor and the clay plaster would have been built of a refractory fireclay. The plastering is done with a wooden trowel (Plate 65*d*).

The kiln building demonstration did not proceed beyond this point, as the remaining construction is uncomplicated. Both the circular inner, or chamber, wall, and the square outer, or insulating, wall would be continued upwards vertically until the height of the chamber was approximately the same as its interior diameter. Then the top of the kiln would be partially closed over by corbelling, leaving a central hole large enough for a man to reach down inside for setting.

The Din brothers work on a two week production cycle. Sufficient pottery is produced in two weeks to set and fire both kilns, resulting in one bullock-cart load of pots. Two people are required to set a kiln, one remaining inside the kiln during the setting and the other bringing the vessels for him to place in position. Only glazed ware is fired in the updraft kilns. Vessels are placed in vertical stacks with the use of setters (Plate 81) and three-pointed stilts. The potters make both the setters and stilts themselves, from the same clay used for making the pottery; the setters are thrown on the wheel and the stilts free-formed. Both are biscuit fired before use.

The setters and stilts are used in the following way. First, a setter is placed on the chamber floor, with the smaller diameter end upwards. A stilt is then placed on this, with the three points facing upwards. Further setting depends on the vessel type. For bowls, a bowl is placed upside down, resting concentrically on the three points of the stilt. Another stilt is then

placed, three points upward, on the foot-ring of this bowl. Another bowl is then placed upside down on this stilt. The setting of bowls is continued in this manner, with alternating stilts and bowls, all stilts pointing upwards and all bowls upside down. Setting the bowls upside down removes the possibility of grit falling into the bowls, particularly undesirable when the glazes are molten. Bowls are glazed on the interior only, the exterior surfaces having neither glaze nor slip applied. Normally, only bowls of the same size are placed in one pile, so that one pile contains only large bowls and another only small, not the two mixed. Sufficient space is left between the piles, so that if the pile shifts slightly during the firing, it will not touch a neighboring pile.

Qulpī, lidded storage pots for storage of dough for *capāti,* are set in a similar way, except that the order of stacking is as follows: setter, stilt, vessel, setter, stilt, vessel. Setters are placed between each vessel, the reason being that this deeper vessel does not nest in the same way as bowls do, and the setters are required to give adequate separation between vessels in the stack. The lids for these vessels are fired separately. Both lid and vessel are glazed on exterior and interior surfaces. It should be noted that this method of setting places the points of the stilts in direct contact with glazed surfaces. This means that during firing, the glazed vessel becomes fused to the points of the stilt. Thus, after firing, the stilt has to be broken away from the points where it fuses to the glaze, resulting in the three characteristic scars on the inner surface of all bowls and *qulpī* (Plate 68*e*).

Hookahs (*cilam*) are set without using stilts or setters. Instead, the glaze is wiped away from the rims of these vessels and they are set in piles, the foot of one resting on the rim of another. Because no glazed surfaces are in contact, there is no danger of the vessels fusing together during the firing.

Most of the setting is placed in position while the man doing the setting is still inside the kiln. When space becomes too congested inside the kiln, he climbs out and the rest of the vessels are placed through the hole in the top of the kiln. This opening is then covered over with sherds, the sherds being supported on top of vessels near the opening. The sherds are set loosely, leaving space for draught.

The fuel for firing is wood, the type varying according to availability. At the time of this investigation the potters were using scrap s̱hīs̱ham (*Dalbergia sissoo*), which is obtained at low cost as offcuts from a woodworking factory in Peshawar. Fuel consumption per firing was not noted at Zakhel Bala, but at nearby Pabbi where the kilns and firing techniques are very similar, a potter said that for a firing containing 120 to 140 vessels the fuel consumption is 5 maunds (226 kg) in summer and 6 maunds (272 kg) in winter.

Firing is commenced with a small fire in the firebox; this smoking fire is maintained for three hours, and then the fuel supply is increased so that the stokehole is continuously half to two-thirds filled with wood. The wood is burned primarily near the stokehole rather than in the firebox itself. The firebox serves mainly to collect heat evenly from the burning fuel so that all flues leading to the chamber are fed with an even temperature. The full firing period is maintained for five hours. Roshan Din said that the finishing temperature is judged by observing the color of the flames inside the kiln, as well as the color of the pottery and quality of reflections on the glazed surfaces. He described the correct finishing color simply as "red." Sometimes a small vessel is removed from the kiln to check that the glaze is fused properly. When this point is reached, the firing is terminated by the very direct method of ceasing to add fuel. No other changes, such as closing off flues, are made. This means that the kiln is allowed to cool with drafts of cold air (preheated by the hot firebox) passing through it. This method of cooling can cause the cooling fault known as dunting-cracking through cooling too quickly. However, the potters said that this is uncommon. Vessels are removed after 48 hours of cooling, by which time they are cool enough to hold in the hand.

TYPES OF POTTERY

The majority of glazed ware is made in three principle types: hookahs (*cilam*), vertical fluted incised decoration, glaze applied on exterior only; bowls, in various sizes (Plate 68), decorated with slips, pigments, glazes (Table 2), glazes and slip pigments applied on interior only; jar with lid for storage of kneaded dough (*qulpī* jar with lid) in various sizes, decorated with slips, pigment brushwork, and glazes (Table 2), glaze and slip applied on both exterior and interior of vessel and lid.

Although these three types constitute the major production of glazed ware, a variety of other types are produced, usually on order only. These include plates in various sizes; flower vases; egg-cups; cups and saucers; candleholders; and ash trays. Ash trays, and cups and saucers are only a recent innovation. Production of these types was begun both to cater to the local tourist market and to offer some competition to the modern chinaware market.

GUJRAT, PANJAB

The production of lead-glazed white earthenware vessels was observed at the Raffi Pottery Works, a small factory in Gujrat city. This factory is typical of many in Gujrat. It is organized for mass production of one type of vessel only, bowls of modern design, with stenciled underglaze decoration. The body and glaze compositions are derived from modern European ceramic techniques. Body and glaze are purchased ready for use from ceramic suppliers in Gujrat. The methods used for forming, finishing, and firing ware are semitraditional; the ware is formed by throwing and turning, and the kilns are of updraft design, fired with wood fuel. This factory is at a transitional stage between the completely traditional pottery production, like that of the pottery of Sardar Mahommed, and completely Europeanized industrial plants, employing methods such as forming by slip casting in plaster molds and firing in a downdraft intermittent kiln using oil fuel, and using mechanized materials, processing and handling equipment.

Forming and Finishing Techniques

All employees of the pottery works are specialized in only one aspect of the work. Two throwers and two turners form the bowls; clay is prepared by kneaders, and carriers bring clay to the wheel. Other laborers carry thrown pots outside for drying and transfer them to the turners when the thrown bowls dry to leather hard. Stenciled decorations are applied by another workman, and glaze is applied by dipping by another. Four men are continuously employed to set and draw the two intermittent kilns which are fired in rotation by two stokers.

Bowls are thrown on stick-spun single wheels of semitraditional design, modified for greater efficiency (Figure 22). The single flywheel is cast from cement and is 0.6 m in diameter and 8 cm thick, the rim having a flange underneath to give greater momentum. This flange is cast in one piece with the wheel; it is 10 cm wide and 8 cm deep. A hollow socket is cast into the center base of the wheel; in use this socket rests on a hardwood (*Acacia arabica*) point, fixed on a concrete foundation on the ground. The wooden point in a concrete socket bearing is lubricated with grease. Using this wheel, each thrower makes up to 1000 bowls in a ten-hour working day, throwing off the hump. A 10-kg lump of clay is placed on the wheel to begin, and bowls are thrown by centering sufficient material at the top of the lump

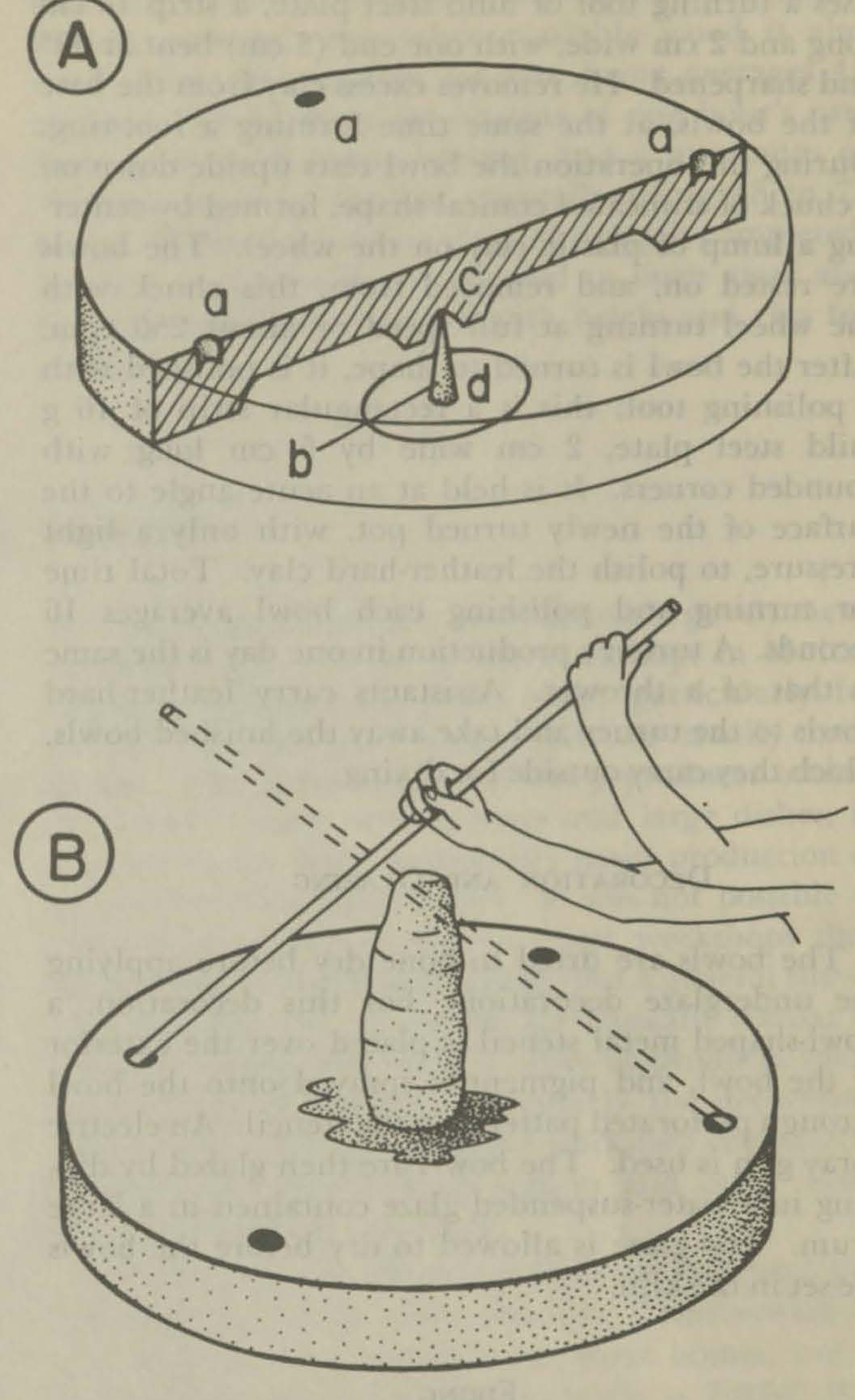


FIGURE 22.—Potter's wheel, Gujrat: A, cross-section (*a*=holes where stick is inserted to propel wheel, *b*=hardwood bearing point, *c*=socket in center of wheel, *d*=concrete foundation for bearing point); B, propelling wheel with stick (note that the stick forms a cone of revolution as it revolves, limiting the size of the vessel that can be formed on the wheel).

for one bowl, throwing the bowl, and cutting it off with a cotton thread attached to one finger of the potter's right hand. Twenty bowls are thrown from one such lump of clay; the wheel is given extra momentum after throwing each four or five bowls, by inserting a stick 0.8 m long and 2.5 cm diameter into a hole near the rim at the top of the wheel and spinning the wheel, holding the stick with both hands.

When the bowls dry to leather hard they are turned on the same type of wheel by a turner. The turner uses a turning tool of mild steel plate, a strip 16 cm long and 2 cm wide, with one end (3 cm) bent at 90° and sharpened. He removes excess clay from the base of the bowls, at the same time forming a foot-ring. During this operation the bowl rests upside down on a chuck of truncated conical shape, formed by centering a lump of plastic clay on the wheel. The bowls are rested on, and removed from, this chuck with the wheel turning at full speed or about 250 rpm. After the bowl is turned to shape, it is polished with a polishing tool; this is a rectangular strip of 16 g mild steel plate, 2 cm wide by 5 cm long with rounded corners. It is held at an acute angle to the surface of the newly turned pot, with only a light pressure, to polish the leather-hard clay. Total time for turning and polishing each bowl averages 16 seconds. A turner's production in one day is the same as that of a thrower. Assistants carry leather-hard bowls to the turner and take away the finished bowls, which they carry outside for drying.

Decoration and Glazing

The bowls are dried to bone dry before applying the underglaze decoration. For this decoration, a bowl-shaped metal stencil is placed over the exterior of the bowl, and pigment is sprayed onto the bowl through perforated patterns in the stencil. An electric spray gun is used. The bowls are then glazed by dipping in a water-suspended glaze contained in a large drum. The glaze is allowed to dry before the bowls are set in the kiln.

Firing

There are two kilns of identical design, in fact constructed together with one wall in common. This common wall both saved bricks in construction and in use serves as a means of preheating the kiln not being fired. The kilns are fired alternately so that one is always either heating or cooling while the other is being set or drawn. Each kiln is fired once every four or five days, with one day for heating and the rest of the time for cooling.

The kilns are the updraft type with a conventional layout, having a firebox at the bottom, a "roof" over this firebox which is also the floor of the setting chamber. The chamber is directly above, and the same diameter as the firebox. The round chamber is 2 m in diameter and 2.1 m high. The chamber floor has 10 flame throats, or flues, 10 cm in diameter equally spaced around the chamber, tangential to the walls, and one central 10 cm diameter flame throat. The domed crown of the chamber has 10 "chimney" flues, each 10 cm in diameter, to exhaust flame from the top of the kiln. These flues are also tangential to the chamber walls; each flue is placed directly between two flame throats on the chamber floor below to discourage chimneying effects. The flues are angled outwards at 30° to the kiln, that is, radically to the crown of the kiln.

The firebox is the same diameter as the chamber, measuring 2 m. The base of the firebox floor curves upward to the circumference. The roof of the firebox is a dome made of brickwork so that in elevation the firebox is elliptical in shape, 1.5 m high at the center. The flues leading to the chamber are 23 cm diameter on the firebox roof, tapering to 10 cm in diameter at the chamber floor. The stokehole at the front of the kiln, where fuel is fed into the firebox, is 1 m high and 0.3 m wide, with an arch at the top. The top of the stokehole arch is 0.3 m below the level of the top of the firebox dome.

The chamber floor inside the kiln is flat. It is built in the following way: First a hole is excavated, and the bottom of this lined with bricks. Then the walls of the circular firebox are constructed from bricks, leaving the stokehole opening. A dome, rising 25 cm is built over the firebox, leaving the flue openings. A portion of the circular chamber walls is then constructed on the circumference of the dome. Unfired clay and brick fragments are used to fill the area above the dome until it is level and the flues are constructed as plastic clay forms in this filling. The flat chamber floor is plastered with fireclay, and the chamber walls are completed. This means that the chamber floor is domed underneath on the firebox side, and flat on top, on the chamber side. This method of construction is similar to that used in building updraft kilns at Zakhel Bala (pp. 83–84).

After the cylindrical firebox and chamber are constructed from a single thickness of brickwork, measuring 11 cm, a square outer wall is constructed around the inner cylindrical structure; the final structure measuring 2.8 sq m in overall dimensions. The gap between the inner circular and outer square walls is filled with clay, for both insulation and strength of the structure. All bricks used in the kiln structure are fired common bricks, not firebrick.

An arched doorway gives access to the chamber of the kiln. The bottom of this doorway is 10 cm above the chamber floor level. The doorway is 1.2 m high and 0.8 m wide, topped by a brick arch of 13 cm rise. When the kiln is being set, one workman stays inside the kiln and three others carry bowls to him for

setting. The bowls are set on circular refractory shelves. The shelves, 0.3 m in diameter, are supported by props made from the same fireclay as the shelves. Setting is standard and does not vary from one firing to the next, so that shelves and props at the back of the kiln are not removed between firings. Those at the front are removed to give access to the back of the kiln. About 4700 bowls are set for each firing, six bowls to each shelf. Each shelf is supported by three props at the circumference. Total setting time is 2½ hours. After the setting is complete, the doorway is sealed with bricks, and a coating of clay is applied to seal the door. The kiln is fired with wood fuel, usually *cīr* (*Pinus longifolia*), *shīsham* (*Dalbergia sissoo*), or *partal* (*Stereospermum suaveolens?*), although any other available wood is also used. Fuel consumption for one firing averages 40 maunds. The firing time consists of one hour's preheating, 6 to 10 hours heating, and a minimum of 32 hours cooling, cooling normally being 48 to 72 hours. When the heating stage of firing is completed, the fuel in the firebox is allowed to burn away and the stokehole is then sealed with bricks and clay for cooling.

MULTAN, PANJAB

The city of Multan is in the southern region of Panjab near to the major route linking Karachi to Lahore by both road and rail. It is close to the Chenab River, one of the five major rivers in Pakistan. The glazed ceramics produced in Multan have attained a wider reputation than those of any other center with the possible exception of Peshawar. Multan Blue pottery was mentioned by the writers of the 19th century, such as Birdwood (1880:138) and Baden-Powell (1872:226). It is mentioned in present-day guidebooks to Pakistani crafts, such as the work of Mirza (1964). Wares from Multan are now sold in many shops throughout Pakistan, which cater to the tourist trade.

Despite this popularity of the pottery, the number of workshops in Multan is very small. In 1971 there were only five workshops operating full-time, producing tiles and decorative domestic wares. One of the workshops was operated by the Pakistan Government's Small Industries Corporation under the supervision of *Ustād* Khuda Baksh. The following description of ceramic techniques was obtained from interviews with, and observations of the work of Khuda Baksh.

Khuda Baksh learned his craft from his father, and the craft is traditional in the family. He worked independently for 25 years before beginning work for the government corporation in the late 1960s. The government workshop was established under his supervision. It is in a different area of Multan city than the traditional workshops which are all located near the Daulat Gate of the old city (the gate being a gate of the old city walls that were demolished during the 19th century; the name of the area has been retained).

The government workshop operates on a slightly different basis than the other workshops in Multan in that its products are sold through government-operated retail outlets. Other workshops in Multan normally produce on order only, particularly for architectural pieces or tiles, which are usually made in sets. The government workshop produces mainly decorative vessels such as vases and large dishes, in contrast to the other workshop's main production of tiles and architectural pieces. It was not possible to carry out detailed studies in other workshops than that supervised by Khuda Baksh, but a general survey indicated that all workshops are basically similar in terms of techniques. The quality of products varies from one to the other, particularly the decoration, which varies considerably, one workshop consistently producing a very fine decoration and other being variable from firing to firing.

The Multan glazed-ware potters are full time professionals, and work all year round. Their workshops are established separately from their homes, unlike those of potters in other areas, such as Zakhel Bala and Hala. Division of skills is evident in each workshop, with apprentices, potters to form the wares, and decorators or master potters to apply glaze and decoration. Although apprentices are usually recruited from within the potter's family, other members of the family are little involved in the work, particularly women who seldom are called on to assist. The tradition of secrecy may in part account for this, although potters are now more willing to discuss their working techniques than they were in the past, according to earlier writers.

Ordinary unglazed ware for domestic use is also produced in and around Multan, but there is no relationship between these potters and those who produce the glazed ware. The making of unglazed ware was not studied in Multan.

Body Materials Gathering and Preparation

According to Khude Baksh, all potters in Multan use the same clay deposit. This is in a field near the tomb of Hafiz Jamal Shah, which is slightly over a kilometer from the Daulat Gate of the old Multan city. The clay deposit is about 200 m southeast of the tomb. It is worked by a miner, who sells it to the potters at one rupee per maund. This covers the cost of both mining and transport to the pottery by bullock cart. Potters usually buy clay by the bullock-cart load, weighing seven or eight maunds. It is also possible for the potters to mine their own clay free of charge if they so wish. The clay occurs in lenses which from time to time are worked out, the digging then being moved to another deposit in the same area. Khuda Baksh said that the various deposits are identical. His reasons for using clay from this specific area are that the clay is even and fine, with few coarse inclusions; it has better fired strength than other clay deposits around Multan; and the deposit is not saline, as are other deposits in the Multan area. Baksh said he understands the deposits now used for blue and white pottery have been in use for more than 200 years.

Apart from the blue and white pottery, red earthenware, such as cooking pots and water storage jars, are made around Multan, and other clay deposits are used for this purpose.

The clay is prepared by two methods: one, using fresh clay brought in from the deposits of raw material; the other recycled waste clay from the pottery.

For waste clay recycling, the material used is waste (*churā*) from the pottery: trimmings produced from the turning of pots, pieces of clay that dried too much to be useful, and pieces of clay used in intermediate processes such as for the chucks. This waste material is prepared when some two to three maunds are accumulated. The material is placed on a prepared area on the ground so that impurities are not introduced from the ground surface. Lumps are broken up with a stick, and the clay is then spread in a hollow centered pile. Water is sprinkled evenly over the surface of the pile. The amount of water varies according to how wet or dry the clay is initially, but about 6 gallons per 3 maunds of clay is an average amount. This represents about 25 percent by weight of added water. The material is then left for two to four days to soak, again depending on how wet or dry the clay is initially; and also how urgently it is required for use. Occasionally, during the soaking, material is moved from the edge of the pile to the center.

Raw clay (*miṭṭī*) brought in by bullock-cart from the deposit is stored in a pile on the ground in one corner of the workshop until ready for use. The moisture content of this clay is variable, so the first stage in processing is to spread the clay on the ground in the sun so it can dry for two or three days depending on how wet it is originally. When the clay is spread on the ground the larger lumps are broken to about fist-size to speed up the drying.

When the clay is dry the lumps are further broken up with a stick so that the largest pieces remaining are all smaller than 2–3 cm in diameter. This is the finest size to which the clay is crushed; the clay is not sieved at any stage. It is usually fine textured and free from any coarse grit, so that the potter's practice is to remove any lumps or small stones at the stage of kneading, or during throwing, or finally in the fettling before glazing.

After the clay is dried and crushed, it is weighed. Usually eight maunds are used as the basic amount of clay for body preparation. This gives sufficient body for two weeks production in the workshop. After weighing, the clay is again spread on the ground. Sand for addition to the body is then weighed, in proportion to the amount of clay. The standard proportions are 1 maund (40 seers) of dry clay (4 parts or 80 percent by weight), and 10 seers of sand (1 part or 20 percent by weight). The weighing of body materials, as opposed to the normal practice of determining proportions of materials by judgment and experience is the only real departure from the usual Pakistani methods of body preparation.

Once the materials are weighed, the body is prepared in the normal manner, by spreading the clay on the ground in a flat hollow conical pile, adding water to the hollow center of the pile, leaving the clay to soak and absorb the water, and occasionally moving material from the dry circumference to the wet center of the pile so that the clay becomes evenly wetted. After one day, sand is added to the wet clay by sprinkling the sand over the clay and blending by foot-kneading of about one maund of the mixture at a time. This means in practice that the sand and clay are not perfectly proportioned within each one-maund batch, so that the proportion of sand to clay in the body finally used on the wheel varies, despite the earlier weighing. The skill and judgment of the potter should be considered, however, as an important factor in maintaining constancy of composition in the body.

For kneading, each maund of clay is trodden into a flat-round pile, which is then doubled over and troddened out again. Each maund of clay is kneaded three times, each time for one and a half hours. Between each of these kneadings the whole mass is

turned upside down. This insures complete blending of the clay and sand and also an even distribution of moisture in the body. This preparation and kneading is done by either the thrower or an assistant, not by the master potter.

After kneading, the plastic body is stored under wet jute sacking in a shaded area of the workshop. The sacking is wetted periodically so it remains permanently moist. This method of storage is standard in all workshops visited in Multan, unlike other hot and dry locations in the Panjab where the potters store clay in underground pits.

Khuda Baksh described another method of clay preparation, which is used in Multan only for bodies to be used for unglazed porous earthenware water pitchers, and not for the blue-and-white pottery. Common salt (NaCl) is used as a body additive. The clay is the same as that used in the making of blue-and-white pottery. The salt is added to the water used for soaking the clay, in the proportion of 1½ *chiṭānk* of salt for 20 seers of clay, or approximately one-half of 1 percent salt. The salt water is then added to the dry clay and the body is then prepared as just described with the same addition of 20 percent sand.

Forming Techniques of Vessels

The products of most Multan workshops can be divided into two major categories; tiles and architectural pieces, and decorative wares. Examples of the latter include vases, dishes, and other domestic vessels. The forming processes used in the two different categories are sufficiently unrelated that they are presented separately.

The forming processes used for decorative wares may be summarized as throwing on the potter's wheel, and turning or joining separately formed pieces in the leather-hard state.

In the pottery workshop supervised by Khuda Baksh all the forming operations are done by one potter, a *kumhār* (the term meaning in this case, "a skilled person who forms pottery vessels"). The *ustād* (master potter) does not do this work, but concentrates on the glazing and decoration of the wares. However, the title "*ustād*" implies that he is skilled in all aspects of the craft, and therefore has the skill to form vessels and particularly to teach others the techniques.

The first step in the forming of vessels is to knead the clay body so it becomes even in moisture content and so that air bubbles are removed. In normal production the potter, Sahib Yar, prepares about 20 kg of plastic clay body (*sinnī miṭṭī*) and then works at the wheel until this amount of clay is used, before preparing more. For this demonstration he prepares a smaller amount of clay. About 6 km of clay body is placed on a piece of jute sack on the ground, and then trodden out to a flat shape (Plate 70). This flat lump is doubled and then again trodden to a flat shape. This treading and folding is repeated for 10 to 12 cycles. The clay is then kneaded by hand. Sahib Yar said that sometimes the clay is a little too stiff for throwing, in which case he sprinkles some water over the clay during both foot- and hand-kneading. For hand-kneading, the clay is divided into lumps (*thōbī*) each weighing about 3 kg. The lump is placed on the same jute sacking as was used for the foot-kneading (Plate 70) and rolled to a cylindrical shape. With the long axis of the cylinder placed parallel to his body the potter pushes down and outwards with the heels of both hands to flatten the cylinder, and then rolls the flattened piece of clay back to a cylindrical form. This alternate flattening and rolling cycle is repeated for about 10 cycles before the clay is considered ready for use on the wheel.

The Multan potters use a pit wheel (*cak*) of the type described elsewhere (pp. 17–19). The traditional iron point and stone cup lower bearing have been replaced by a modern ball bearing race at the bottom of the shaft. The pit (*khaḍḍā*) is excavated in the earth floor of the workshop but is not brick lined, in contrast with normal Panjabi practice.

Several of the common techniques used for forming vessels were demonstrated by Sahib Yar. The most economical in terms of time and labor is to throw vessels in one piece and then refine the shape by turning; small bowls, flower vases and bottle vases are formed in this way. Despite the economy of time, Sahib Yar said that some of these shapes, particularly the bottle shapes, are the most difficult in that they require the greatest skill.

The first stage in throwing is to place a large lump of clay on the wheelhead with the size varying according to the type of vessel to be made, but 5–10 kg of clay is the usual amount. The potter centers (*siddhā*, literally, "straight") the top of the lump and forms a vessel from this centered portion. The vessel is then cut off with a thread (*dhāgā*) held taut between both hands and piled straight through underneath the base of the vessel. When this vessel is placed aside the process is repeated, this continuing until the entire lump of clay is used to produce a number of vessels.

When these vessels dry to leather hard they are turned to thin the walls and refine the shape. Bottles are placed upside down on the wheelhead in a thrown hollow clay chuck; bowls are placed upside

down over a clay chuck, which is formed on the wheelhead to correspond to the interior shape of the bowls. The turning tool is a piece of sheet steel about 2 cm wide and 20 cm long with one end (3 cm long) bent at 90° to form a cutting edge, the longer end serving as a handle. After the shape is defined by turning, vessels are polished with a circular piece of sheet metal about 8 cm diameter held at an acute angle to the wall of the vessel as it revolves on the wheel. The chucks used for turning are formed from soft plastic clay, and modified to different shapes if the potter turns a batch of vessels of different types in one sitting, rather than forming a completely new chuck for each type of vessel.

Hollow ware such as plates and large shallow dishes are formed by another method. The potter first places three small pieces of soft clay on the wheelhead. He then places a fired tile on these three pieces of clay and presses the tile down firmly so that it is fixed to the pieces of clay and hence the wheelhead (Plate 70). A lump of kneaded clay of the correct weight for the vessel being formed is then placed on the tile, centered, and thrown to shape. The tile, with the vessel still fixed to it, is lifted from the wheelhead and placed aside for the dish or plate to dry to leather hard. The vessel is then cut from the tile and turned in the normal way. This technique is used because of the difficulty of removing a hollow ware vessel thrown directly on the wheelhead, without distorting the soft piece. By using the tile the potter is able to avoid touching the plate or dish until it has dried enough to withstand handling without distortion.

Another common forming technique is to form vessels in sections, separate pieces being thrown and then joined together when they are leather hard. Sahib Yar demonstrated this technique as used for forming a large flower vase (*guldān*) (Plate 71). The potter places a large lump of kneaded clay, sufficient to make all the separate parts of one vessel, on the wheelhead and then begins to throw the separate parts of the vessel: the central body section, the top section, neck and rim combined, and the foot. A scalloped rim is formed on the neck by forming a series of spouts around the rim before the piece is removed from the wheel. The separate pieces of the vessel are then placed aside to dry to leather hard (*kurāṛī*). When this stage is reached, the potter forms a chuck on the wheelhead from plastic clay. This chuck is formed as a hollow-centered ring of clay. Into this he places the central body portion of the vessel, upside down. The shape of this section is then refined by turning.

The potter then prepares to join the foot to the central body section of the vessel. He takes some plastic body clay, and blends shredded raw cotton with the clay by hand. The raw cotton is prepared by shredding with the hands until all the pieces are very fine. The amount of cotton added to the body clay is estimated at four parts of clay to one part of compressed cotton. The potter explained that the cotton reduces the shrinkage of the plastic clay so that the leather-hard sections of the vessel have the same shrinkage as the plastic joints, and thus there is no cracking of the vessel due to uneven drying shrinkage stresses.

With the central body section still upside down on the wheel after turning, the potter is ready to join the foot to the central section. He forms a lump from the cotton-tempered clay and places this lump on the solid base of the central section. The lump is then thrown to an even section. The base of the vessel is then wetted and placed in position on the soft clay newly added to the base. Then, pressing down firmly on the foot section and with his other hand blending the soft clay into the profile of the two sections being joined, he completes the joining.

The vessel is then removed from the wheel. In normal production these vessels are made in batches and this operation is repeated for a number of vessels before the first day enough for the next stage, which is to add the neck section. For this the chuck is removed from the wheelhead, and the vessel placed upright on the wheelhead. The neck is then joined to the top of the central body section by similar methods to those which are used to join the foot. The completed vessel is then placed in a suitable area to dry to bone dry (*sukkī*, "dry") condition.

The technique of forming vessels by joining separately thrown pieces is used for other vessel types made in Multan, including *surāhī;* and several forms which incorporate a separately thrown and joined foot, such as footed bowls, flowerpots and jugs (Plate 73).

Forming Techniques of Tiles

Tiles are the major ceramic product in Multan; tiles for recent tombs being the major output, but also tiles to be used in the continuous program of renovation of older tombs and mosques. Most of these tiles are used locally, by contrast with the production of hollow ware pottery, much of which is consumed by a tourist market or exported to other Pakistani cities for sale.

Tiles are made from the same body used in the making of hollow ware pottery. This clay is stored under wet bags in the workshop to keep it moist.

In a few Multan workshops a continuous supply of about half a ton of clay is kept, as the output is high. Most Multan potters produce tiles on individual order, sometimes as small as only one tile, and their amount of plastic body in stock is much smaller. Each tile maker has a range of standard designs, from which usually the customer selects his preference. If necessary, the makers produce any shape of tiles for specific applications; the painted decoration is adapted to that shape from one of the standard decorative motifs.

The actual forming of tiles is a simple, uncomplicated process. The most common tile shapes are square, rectangular, and arch-shaped tomb plaques (that is, a basically rectangular shape with one end cut down to a pointed arch shape). Special tiles are perforated or shaped to suit a specific application. The basic forming of all shapes is done by standard processes.

An amount of body adequate for the size of tile to be made is taken from stock; the potter does not weigh the material but selects the appropriate amount on the basis of judgment. The clay is kneaded quickly by hand. The tile is then shaped roughly on a flat area of the earth floor, by beating out the clay with the heels of the hand. The size of the pad of clay produced is larger than the size of the final tile—both drying and firing shrinkage are allowed for at this stage. The tile is then left to dry to leather hard.

The edges are trimmed to size. For square tiles, a rule and tri-square are used to set out the dimensions accurately with allowances made for shrinkage. A chisel is used to trim the edges to size. More complex shapes, in normal production, are set out with the aid of a sheet-metal template.

Some tiles have recessed areas on the face which are hollowed with a knife at the leather-hard stage. Th most common example of this type of tiles is the *lauh-i mazār* tiles, used as gravestones or tomb inscription plates. The recessed area eventually becomes the area with a written inscription and the raised border area serves as a frame (Plate 76). During ing these forming operations the potter sits on the floor and the tile rests on a low, circular stand. If the edges of the tile have been abraded during the previous operations, they are restored to a right-angled edge by building up with a fine coil of clay. If the face of the tile is not flat enough at this leather-hard stage it is scraped down, with a flat sheetmetal scraper. It is also at this stage that the holes are cut in perforated tiles. The limits of the holes are marked out and the holes cut with a fine-bladed knife; waste pieces are pushed out and returned to the waste clay stockpile to be reprocessed later.

Frogs, or hollows to enable the plaster to grip the tiles when they are set on a wall, are also made at the leather-hard stage. These appear as a regular pattern of triangular recesses on the back of fired tiles (Plate 76) and are formed by pushing the tip of a broad-bladed knife at a shallow angle into the clay and then quickly lifting up and removing the waste material. The frogs are usually about 0.5 cm deep at the hollow apex with the side opposite this apex being at surface level.

When these operations are completed the tile is set aside to dry out to bone-dry condition. It was observed that no special precautions are taken to avoid warping of the tiles during the drying. Tiles in some workshops are stacked on their ends and rest against one another for drying. With a body that is prone to warping, this procedure would certainly result in badly warped tiles. The thickness of the tiles would be partly responsible for the resistance to warping. For example, measurement of some typical fired tiles show that tiles averaging 15.2 cm square have an average thickness of 1.9 cm, and those averaging 22.6 cm square have an average thickness of 2.7 cm.

When the tiles are bone dry, they are fettled and prepared for slipping, decorating, and glazing in the same way as the domestic ware.

For a larger production of tiles, when the number involved is much greater, the workshop employs a specialist tile maker instead of having tiles made in the workshop by the *kumhār*. This specialist in turn employs another man to prepare body for him. The prepared body is stored in front of the workshop under wet bags, in lots of about 500 kilograms.

The tiles are formed in a continuous strip along the pavement of the street in front of the potter's workshop. The tile maker takes about 20 kg of body from the main stockpile and kneads it by foot in front of the workshop, carries it across the street, and places it in a pile on the pavement. He takes about 5 kg of material and throws it on the pavement so that it spreads into a flat lump. Then, bending over the clay, he uses both hands to pat it down flat to the required thickness. A measuring stick laid across the top of the batt of clay being formed allows the tile maker to form the batt to precise width. Any excess material at the sides of the batt is removed by scraping it off with the sides of the index finger. As the strip of clay is extended, the measuring stick is moved continuously toward the tile maker, so that it always rests as close as possible to the area being formed.

The surface of the pavement used as a forming area is brick, hence somewhat irregular, so that the strip of clay being formed varies in thickness. The top

surface is level to within half a centimeter only, so that the tiles will later require careful smoothing and finishing. One day's production of tiles uses about 6 maunds of clay, resulting in a strip about 11 m long along the pavement and 60 cm wide. This represents two and a half hours of work by one tile maker. Included in this working time is the time taken to cross the street and obtain another 20 kg of clay body from the stockpile each time one of these batches is used.

The next stage in tile forming is to cut this large strip of clay into pieces corresponding to size of tiles. As the width of the strip of clay is fixed, this operation is simplified by the use of a measuring stick, the length of which is the same as the initial measuring stick used to set out the width of the strip of clay. The measuring stick is marked with grooves corresponding to various standard sizes of tile; lengths represented allow for drying and firing shrinkage of the clay.

The tile maker marks along the entire length of the strip, keeping the ends of the measuring stick level with the sides of the strip, and using the point of a knife to mark the clay. This knife is broad bladed, with a rounded end. He cuts along the entire length of the strip, along each line, using the knife freehand without any form or support. The cut is made to a depth corresponding to half the thickness of the tiles; the clay is not cut right through. This minimizes warping as the clay dries. Again using the measuring stick to mark off lengths, the tile maker finishes the tile cutting by cutting transversely across the strip. The strip is then left to dry to leather hard. When this stage has been reached, the individual tiles are broken away from the strip and the edges trimmed square with a knife. Individual tiles are then finished by the methods described above.

Preparation of Glaze and Slip

The outline of glaze preparation should be compared with the description written for Rye by Khuda Baksh (Appendix 2).

Materials.—The Multan potters use two basic materials for glaze making, quartzite stone and calcined plant ash. Borax usually is used in most glaze compositions. Ground glass is also used as a cheap addition to glazes by some potters.

The quartzite (*karunḍ*) is obtained from a deposit of this material at Sakhi Sarwar, some 80 km from Dera Ghazi Khan city, according to Khuda Baksh. The exact site of the deposit was not revealed. Potters from Multān collect the materials themselves on a cooperative basis. They hire a truck collectively, and one potter accompanies the truck driver to insure that the correct material is obtained from the deposit. About 6000–7000 kg of quartzite is obtained on each trip. The material is obtained free of cost at the deposit so the potters share only the expense of transport. The quartzite is in the form of river pebbles (some weighing as much as 20 to 30 kg), rather than massive deposits which would require blasting or other complex mining techniques. No informants were able to say how long this deposit has been used by Multan potters.

The *karunḍ* stone is prepared for glaze making by first breaking up the large lumps with a hammer, and then crushing these pieces with an iron mortar and pestle (*imām-dastā*). The powder obtained from this crushing is all finer than 1 to 2 mm. This powder is then washed by placing it in a vessel and pouring in water to cover the powder, stirring the mixture, and then pouring off the water. This washing is repeated three or four times until the water is clear after stirring the powder.

The purpose of the washing is mainly to remove small pieces of plant and other organic material, which have become mixed with the quartzite powder. No fraction of the quartzite itself is separated. After washing, the *karunḍ* powder is spread out on a piece of finely woven cloth and sun dried.

Plant ash (*khār*) is obtained from dealers in the Multan bazaar. The potters do not know in detail where the calcined plant ash is prepared, although Khuda Baksh suggested that it came from the Cholistan Desert. Subsequent investigation revealed that large quantities of *khār* are produced in the Cholistan region, near Bahawalpur. The production of *khār* is outlined in Appendix 3. The *khār* is purchased in the form of rock-like blocks, varying in size but typically about 15 cm in diameter. These lumps are broken up at the workshop, with an iron mortar and pestle (*imām-dastā*). The powder resulting from this crushing is all finer than 1 to 2 mm, particle size.

Borax (*sohāgā*) is purchased in the Multan Bazaar. It is sold in the form of medium-sized crystals, ranging from 1–5 cm, and is not further prepared in any way by the potters.

Glass (*s̱hīs̱ha*, glass in cullet form) is also purchased from dealers in the Multan bazaar. The potters buy only clear window or bottle glass that has no pieces of colored glass intermixed. The pieces of broken glass are crushed with an iron mortar and pestle, and the resulting material is then finely ground in a stone quern (*cakkī*). After grinding, the resulting powder was described by the Multani term "*kac*." This term caused some confusion during interviews with the

potters, because the potters refer to both powdered *glass* and to powdered *glaze* as "*kac*."

GRINDING.—The stone quern used for grinding in the workshop of Khuda Baksh is shown in Figure 23 and in Plate 73*b*. The lower stone disc (*nīce-vālā*) is fixed, and the upper stone disc (*ūpar-vālā*) revolves via a wooden handle (*hatthā*) fixed permanently in a hole in the top disc. The bottom stone rests on a platform made from clay and straw, with a trough around the perimeter of the bottom disc. Ground material collects in this trough. The material to be ground is introduced through a central hole in the upper stone. The fineness of grinding is controlled by raising or lowering the top stone by driving a wedge under the wooden support carrying the steel point on which the top stone revolves. The wooden support and wedge are located in a tunnel passing underneath the clay platform, which supports the lower stone.

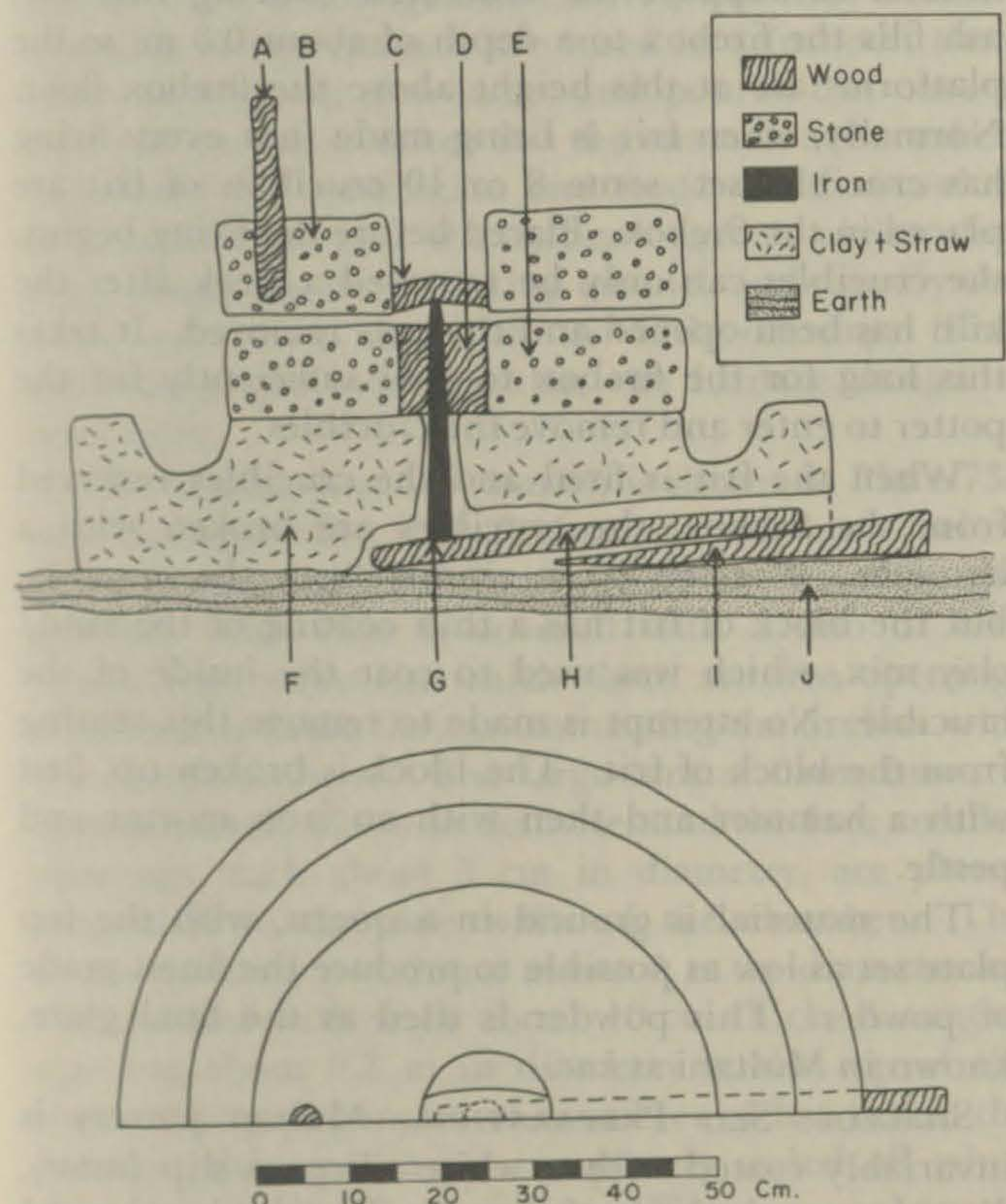


FIGURE 23.—Potter's quern for grinding glaze materials, Multan, Panjab: *top*, sectioned elevation, *below*, half-plan. (A=wooden handle, B=upper revolving grinding stone, C=wooden bearing socket, fixed to top stone, D=wooden plug fixed to lower stone, E=lower stationary grinding stone, F=mixed clay/straw foundation with trough around perimeter where ground material accumulates, G=iron spindle, which supports weight of top stone, H=movable wooden support for iron spindle, I=wedge, moving the wedge in or out raises or lowers the top stone, regulating particle size of ground product, J=earthen floor of workshop.)

FURTHER GLAZE PREPARATION.—The first stage of glaze preparation, that is the obtaining and preparing of raw materials, has been described. The next stage is to mix the powdered *khār* and *karunḍ*. Usually 10–15 kgs are prepared at one time. The powders of the two materials are weighed to give batches consisting of equal amounts of each material. The batches of 50 percent by weight *khār*, 50 percent by weight *karunḍ*, are then mixed in an iron dish.

When the blend is thoroughly mixed by hand, cold water is sprinkled over the powder. A minimum of water is used, just enough to wet the powder. When the moisture is evenly distributed through the powder, portions are removed and formed by hand into balls (*golā*). These balls, each about 10 cm in diameter, are placed in the sun to dry for 10–15 days. As they dry a white efflorescence forms on the surface of the originally dark green colored balls.

The balls are then sintered in the kiln. At the end of a normal firing, when the kiln reaches maximum temperature and the stoking ceases, so that there is no more smoke and only ash is left in the firebox, the balls are thrown into the bottom of the firebox. The shock is cushioned by the soft bed of ashes in the firebox. The mouth of the stokehole is then sealed off so that no cold air can enter the kiln and damage the pots inside. The kiln cools for three to four days.

Since the potter Khuda Baksh said that the firebox at this stage is still red hot, the temperature in the firebox is estimated at around 900°C (pp. 143–146). The balls heat very quickly when placed in the firebox, and then cool slowly over the remainder of the 3–4 day period.

When the kiln cools, the balls are removed from the firebox. Inspection of a number of these once-fired balls showed that they are quite variable in appearance. Extensive fusion of the *khār* occurs, giving a matrix of vitreous material (Plate 74*d*,*e*). In some areas an almost clear glass forms, in other areas little more than sintering. Some larger particles of *karunḍ* are dispersed through the vitreous matrix; these larger particles show signs of attack by the glass around the edges. Some balls, which were resting at the bottom of the kiln, have a deposit of wood ash from the firebox adhering to one side. This ash deposit is sintered to the ball and would be incorporated in the final glaze. Other balls show only very slight traces of ash deposit. All balls vary in color. The area which was resting on ash has a light grayish color, the central portion appears dark green, and the upper portion, which underwent the greatest fusion is also a light grayish color, with a vitreous luster. The balls fused enough to distort slightly from their

original spherical shape, approximately to the proportions of height equaling 66 percent of the diameter.

The balls are crushed using an iron mortar and pestle. This crushing does not produce an extremely fine powder, some particles still being as large as 3–4 mm, although this is exceptional.

The procedure described to this point is standard for each glaze batch prepared by Khuda Baksh. After that stage, the procedure varies from batch to batch, and Khuda Baksh said that other potters use variations which are different to his. In general, the next stage is to add a fusible material, such as borax (*sohāgā*), or ground glass, to the powder obtained by crushing the fused *khār/karunḍ* balls. Both the type and the amount of the addition are variable, depending on different potters' preferences as to which material to add, and also dependent on the degree of fusion of the initial balls.

Khuda Baksh normally adds borax (sodium borate, $Na_2B_4O_7 \cdot 10H_2O$). If, in his judgment, the balls fuse normally, the borax addition is as follows: *add* 1 part by weight of crystalline borax *to* 16 parts by weight of crushed fused *khār/karunḍ* balls. These proportions are varied according to the degree of initial fusion of balls. If fusion is more extensive than "normal," then less borax is added; for example, one part of borax to 48 parts of *khār/karunḍ* powder. If, on the other hand, the *khār/karunḍ* mixture is only sintered, with little accompanying fusion, then more borax than normal is added.

A further variation in Multan, according to Khuda Baksh, is the use of ordinary cullet, crushed bottle and window glass, in glazes. He did not know how long this procedure had been in use, but thought its introduction was recent. The practice of adding glass to the glaze is understandable in economic terms, the cost of prepared glaze being in the order of two rupees per seer and the cost of cullet being four annas (25 paisa, 100 paisa/rupee) per seer. Khuda Baksh was reluctant to talk about the use of glass in glazes, as he said that the glazes with glass added are of inferior quality. He said that some typical mixtures used by other potters, and occasionally by himself, are (1) half a seer of glass to two seers of *khār/karunḍ;* (2) two parts of *khār/karunḍ,* one part of powdered glass, a half part of borax. Considering that this information was given somewhat unwillingly, due to it being viewed as professionally secret, it must be regarded as not completely reliable. It seems, though, that the practice of adding cullet to the glaze is being used in Multan, and that the resulting glazes are inferior to the normal glazes, particularly in that the cullet glazes flake off the fired pottery more readily than the normal glazes, and are prone to crazing. Khuda Baksh said that the normal glaze also tends to lift off the body if not fired to full maturity.

In the normal glaze preparation, where one part of borax added to 16 parts of the *khār/karunḍ,* the borax is added in the form of powdered crystalline material. The two powders are thoroughly mixed by hand in a large dish. This mixture is then placed in crucibles (*daurī*), which are unfired, made from the ordinary pottery body, and similar to an ordinary flowerpot (15 cm high, 15 cm diameter at the top, and 11 cm in diameter at the base). Thrown on the potter's wheel, before use, the interior is painted with a thin wash of 50 percent body clay and 50 percent sand, to prevent complete fusion of the frit to the crucible.

The coated crucibles are filled almost to the rim with the *khār/karunḍ* mix and placed in the firebox of the kiln before an ordinary glaze firing begins. Special brick platforms are built along the sides of the firebox to support the crucibles. During full fire, ash fills the firebox to a depth of about 0.3 m, so the platforms are at this height above the firebox floor. Normally, when frit is being made (not every firing has crucibles set) some 8 or 10 crucibles of frit are placed in the firebox. Placed before the firing begins, the crucibles can only be removed a week after the kiln has been opened and the pots removed. It takes this long for the firebox to cool sufficiently for the potter to enter and remove the crucibles.

When the frit is fired and the crucibles removed from the firebox, the crucibles are broken with a hammer. The frit parts readily from the crucible, but the block of frit has a thin coating of the sand/clay mix, which was used to coat the inside of the crucible. No attempt is made to remove this coating from the block of frit. The block is broken up, first with a hammer and then with an iron mortar and pestle.

The material is ground in a quern, with the top plate set as low as possible to produce the finest grade of powder. This powder is used as the final glaze, known in Multani as *kac*.

SILICEOUS SLIP PREPARATION.—Multan pottery is invariably coated with a white siliceous slip (*astar*), directly over the body of the pot. The slip is prepared in conjunction with the glaze as it is based on very similar materials. The basic steps in the preparation of *astar* are identical to those of glaze preparation up to the point where the final glaze or frit is removed from the kiln in crucibles. That is to say, one ingredient of the siliceous slip is the *kac,* or frit. The frit is broken up in an iron mortar and pestle to a particle size all finer than 1–2 mm.

The other ingredient of the siliceous slip is *karunḍ*. The *karunḍ* is used in powder form and is prepared as described above for glaze preparation. The two powders are weighed out in equal proportions (i.e., 50 percent *kac*, 50 percent *karunḍ*). The powders are mixed by hand in a large dish. When the mixture is homogeneous the *astar* is then finely ground in a quern, and, in this form, is ready for use.

FRIT FURNACE.—The glaze frits prepared by Khuda Baksh are fused in the same kiln as used to fire pottery and tiles, but in 1971 a small frit furnace had just been constructed and was ready for use. According to Khuda Baksh, this furnace is constructed according to an ancient design, but he did not know where the design had originated; he had obtained it from his father.

The frit furnace is very similar in size and function to a furnace type used in Lahore for fusing glass enamels, enamels used on jewelry. Only one family in Lahore is making these enamels and their compositions are a closely guarded secret, but they demonstrated how the enamels are fused in a furnace, then removed with an iron ladle, and poured out onto a steel plate to cool. After this the enamels are crushed to powder for application and fused on the jewelry. It is significant that the enamel makers claim that their family has been making enamels in basically the same way since the 16th or 17th century. This strengthens the evidence that the furnace design is not recent.

The Multan furnace (*maṭkā*) is shown in Plate 73*a* and in Figure 24. The firebox is completely below ground level, in the form of a hole excavated in the ground. This hole is covered with a slab of clay mixed with straw, in which there are five openings which act as flame throats connecting the firebox with the chamber above. The large central flamethroat is approximately 20 cm in diameter and the four smaller openings, each about 5 cm in diameter, are placed tangential to the side walls of the chamber. The chamber itself is a dome about 1 m in diameter on the exterior with walls about 10 cm thick. A central opening about 0.3 m in diameter at the top of the dome allows placement of crucibles of frit inside the furnace; this opening is completely sealed off when the furnace is in operation. Flame is exhausted through eight flues around the sides of the furnace; each of these holes is approximately 7 cm diameter at the exterior of the furnace.

The furnace at this workshop was not seen in operation, but Khuda Baksh had previously used a frit furnace of identical design. He said that the frit is placed in crucibles as described above, and that these crucibles are placed around the floor of the furnace. After the top is sealed the furnace is heated for seven hours, consuming 200 kg of wood fuel. No estimate of temperature reached in the furnace could be obtained.

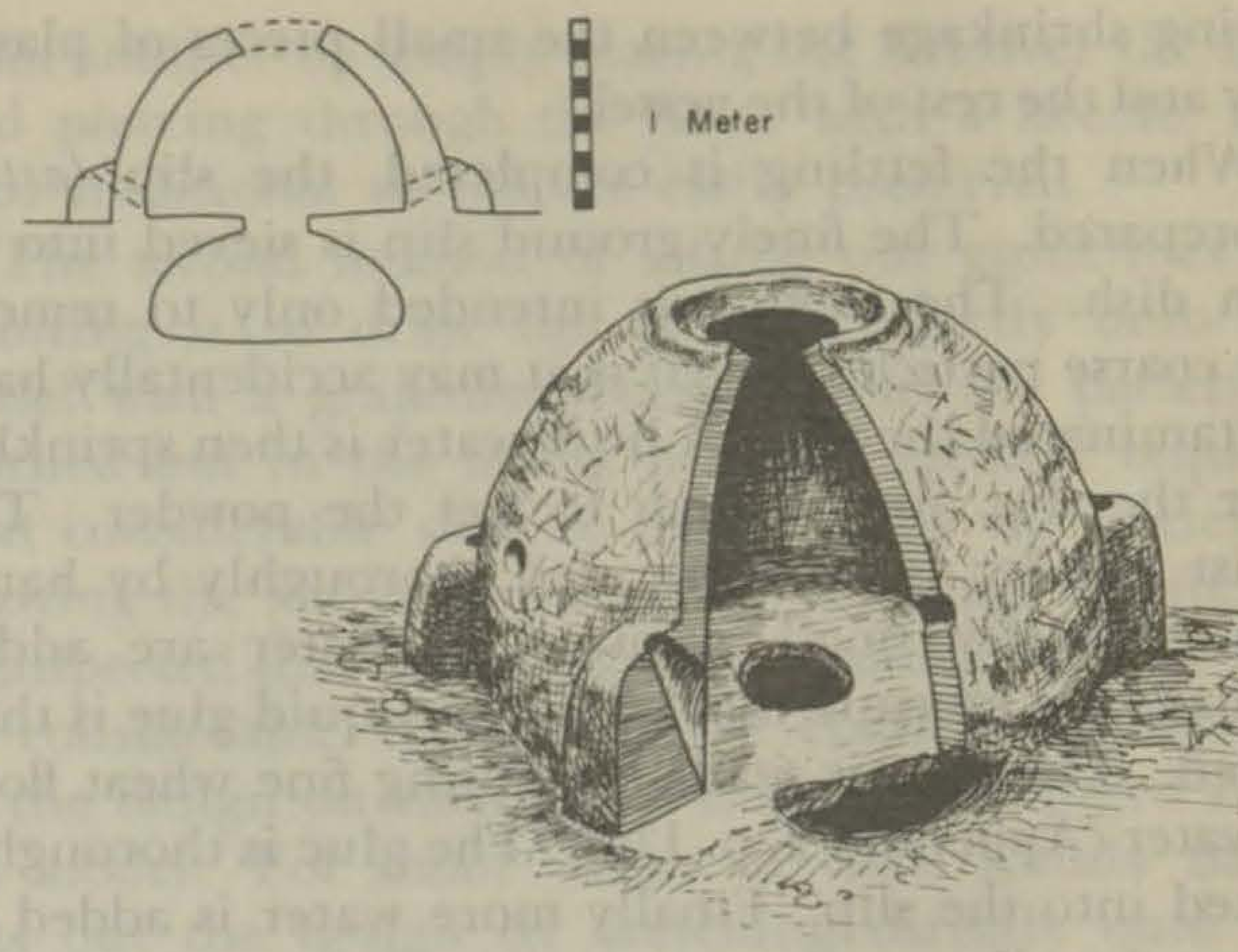


FIGURE 24.—Multan frit furnace with part sectioned perspective view. Stokehole at front, ground level. Inset shows location and relative sizes of firebox and chamber. Firebox completely below ground level; chamber completely above.

APPLICATION OF SLIP AND GLAZE

After preparation of the raw materials, both slip and glaze are in the form of dry powders. Both are applied by similar techniques, but at different times. The slip is applied to vessels or tiles when they are completely dried after forming. The decoration is applied over the slip when it has dried (pp. 81-83) and then the glaze is applied as the final stage before firing the vessels or tiles.

Slip and glaze are usually applied to a batch of ware, so that only the amount of slip or glaze needed is prepared for the batch. The application of slip is described as the process is slightly more involved than that for application of glaze. The process is shown in Plate 72.

The first step, before slip is applied, is fettling or repairing any damage that occurred to the vessels in drying or storage, or smoothing the surfaces. Vessels to be fettled (*marammat karnā*, "to repair") are placed conveniently grouped together in the working area. He smooths the exterior of vessels (or the face of tiles) with a cloth which is dipped in the slurry, rubbing over any imperfections on the surface. The slurry (*vīliyā*) wets the surface enough for the next stage, which is to fill any small holes in the surface with pieces of plastic body. The holes are small enough that no problems are caused by differential

drying shrinkage between the small pieces of plastic clay and the rest of the vessel.

When the fettling is completed, the slip (*astar*) is prepared. The finely ground slip is sieved into an iron dish. The sieving is intended only to remove any coarse particles of grit that may accidentally have contaminated the slip. A little water is then sprinkled over the slip, just enough to wet the powder. The moist powder is then kneaded thoroughly by hand, and gradually small amounts of water are added to make the mixture more fluid. A liquid glue is then added. The glue is made by boiling fine wheat flour in water (Appendix 2, p. 179). The glue is thoroughly mixed into the slip. Finally more water is added to bring the slip to the correct consistency for application.

The slip is applied to the vessels by pouring. Two coatings are applied to each vessel. First some slip is scooped up by hand and poured over the vessel, which is held so that excess slip flows back into the iron dish. This layer of slip is rubbed off while it is still wet. Then, another coating is poured over the vessel, which rests on a piece of wood placed across the top of the iron dish, allowing the excess slip to flow back into the iron dish. When the coating has dried sufficiently, indicated by the gloss disappearing from the surface, the vessel is placed aside to dry.

The slip coating when dry is quite durable and remains undamaged despite repeated handling of the vessel during drying and decorating, but Khuda Baksh said that if glue were not added to the slip it would brush off easily.

The vessels or tiles are decorated after they are again completely dry. Then the glaze was applied. The glaze is prepared for application in exactly the same way as the slip, but only one coating is applied. This coating is poured on by hand, very skilfully so as not to damage the slip or decoration underneath. When the glaze coating is dry the vessel or tile is fettled again by rubbing with a wet cloth on areas where glaze is unwanted, such as on the base of vessels, on the rim of those which are to be stacked one upon another in firing, and on the sides or backs of tiles. The main reason for removing this excess glaze is to avoid vessels sticking together where they will be in contact during firing, which can occur if the glaze fuses and cools in contact areas.

Decoration

The painted decoration of the Multan ware is its dominant esthetic characteristic. On tiles the body of the tile functions only as a carrier for the painting; the form of vessels is subordinated to the visual effect of the painting. Only a few forms are complex, the majority being simple and direct in outline, particularly the flatware.

The relative importance of decoration can be seen in the division of craftsmen according to status within their own membership. A potter who has the skill to prepare clay and shape vessels is called "*kumhār*"; his status is similar to that of the potter who makes common unglazed earthenware, and who in fact is given the same title.

A *kumhār* has higher status than an apprentice, and the graduation from apprenticeship is to the status of *kumhār*. A craftsman who is skilled in the art of decorating, a *kās͟hīgar*, has higher status among craftsmen than either the apprentice or the potter. The highest status of all is accorded to the *ustād*, the master, who combines the skills of potter and decorator with a knowledge of the history of his craft, and who is a teacher of all aspects of the craft. A craftsman who reaches the status of *ustād* would have his own workshop, and his role in the workshop would be to apply slip, decorate vessels, and glaze them, as well as teaching others the skills required for their part in the work.

The general term for the art of decoration is "*naqqās͟hī*," which refers to "the art of Islamic floral decoration" as applied in any medium, for example, the decoration of textiles, books, or achitectural decoration using floral motifs. Decoration on pottery or tiles can be described by the general term "*naqqās͟hī*." For ceramics, however, more specific terms are used. "*Kās͟hī-kārī*" is "the art of floral decoration on ceramics," the decoration made by a *kās͟hīgar*. The term "*kaman-garī*" is reserved for one class of architectural work, that in which monochrome glazed bricks or tiles are used (for example, in the façade of the Shah Rukn-i Alam Mosque in Multan). In this class of work painted decoration is not used, but the colored bricks or tile are arranged in decorative patterns by the builders.

Within the work known as "*kās͟hī-kārī*," there are three classes of decoration, divided on the basis of the type of floral motif. These classes are *bel*, vines; *paudā*, plants and flowers; and *darak͟ht*, trees. Specific elements of decoration are further subdivided. The three traditional colors of Multan Blue pottery are cobalt blue (*lājvard*), turquoise (*sabzī*), and white (*cittā*). A fourth color is also commonly used; this is a pale cobalt blue, which can sometimes appear very similar to the turquoise color. Recently, some Multan potters began to use other colors for decoration, primarily green, brown, and yellow used under the glaze, and gold applied over the glaze. These recently introduced colors, in use only since the 1960s,

are produced from commercial pigments imported from England and Europe. The materials and preparation of the blue and turquoise pigment are worthy of detailed discussion. The white color is produced on areas of vessels where the clear glaze is used over the white siliceous slip, that is, on unpainted areas.

The blue (*lājvard*) pigment is based on cobalt oxide. Khuda Baksh uses cobalt oxide imported from Germany by suppliers in Gujrat or Gujranwala, which he purchases in the bazaar in Multan. He said that before this became available the Multan potters used a cobalt ore that they mined themselves, but he could not say where the deposit was located. As supplied, the cobalt oxide in use in 1971 was finely powdered and required no grinding. For painting it is mixed with finely ground black copper oxide in the proportions, by weight of: four parts cobalt oxide to one part copper oxide.

Khuda Baksh said that if cobalt oxide is used alone for painting that the fired color is black, and that the copper oxide helps produce the desired dark blue fired color. The copper and cobalt oxides are mixed thoroughly by placing them in a stone mortar, adding sufficient water to produce a thin paste, and then grinding with a stone pestle.

The turquoise color is produced from black copper oxide. The oxide is obtained as scale from large copper cooking pots, and can be bought in the Multan bazaar. It may be sold by coppersmiths as was the copper oxide (USNM 417,462) used by the Zakhel Bala potters (Table 9). The copper scale is prepared by first grinding in an iron mortar with an iron pestle, then sieving through a sieve with apertures of 0.2 mm, and grinding this powder in a stone mortar using a stone pestle. The powder is ground wet in the same way as the cobalt pigment described above. Khuda Baksh said that to achieve the correct degree of fineness the copper pigment has to be ground for three days.

Before the pigments can be applied to a vessel or tile the motif is set out on the piece by one of two methods. The traditional method of placing guidelines for painting is to form a paper template by piercing fine holes which form lines corresponding to the required motif, then to place this paper template over the tile or vessel and dust finely ground charcoal over the template. When the template is carefully removed the outline of the motif appears as lines made up of black dots to guide the brushwork; the carbon is burned out in the firing. Considerable skill is required to adapt the paper template to the shape of some vessels, such as vases. The advantage of using these templates is that, with careful handling, they last for many years. A template can easily be copied from another by simply placing the old over the new and piercing through the holes with a needle, and thus traditional motifs are easily preserved.

The second method of setting out guidelines for painting is to draw the pattern directly onto the vessel with a graphite pencil. Again the pattern is burned out in the firing, but this method requires that considerable skill be exercised by the potter in copying the pattern from a finished vessel or tile. It is suspected that this fairly recent innovation will lead to considerable changes in the traditional patterns, as the design on each vessel is slightly changed from its model. For small vessels or tiles, Khuda Baksh sets out the design by sketching directly onto the vessel with a pencil, working from memory rather than copying another completed vessel.

With the design set out on the vessel, the potter then completes the painting. One color at a time is applied, and all sections of the pattern requiring this color are completed. The dark blue cobalt color, which is used normally as lines to define a design, is applied first. A small amount of the pigment is placed in a bowl, and water added to bring it to the correct consistency for brushing. Water and pigment are mixed with a brush. The brush is made by the potter, from squirrel hair inserted in the split quill of a large feather and then bound with thread. The quill handle is cut to a length of about 12 cm. The dark blue lines are applied with the tip of the brush (Plate 73).

Any areas requiring a dark blue wash are then completed. For a lighter blue wash, mentioned above, the pigment is further diluted. The distinction between the dark and light blue, not to be confused with turquoise, colors is thus one of thickness of application of the wash, and not one of a different type of pigment. The decorator's skill in applying washes is very evident at this point.

The copper pigment, which is fired to a turquoise color, is applied when all the blue decoration is completed. The turquoise color is used as a wash only, sometimes over large areas, and again considerable skill is required to apply an even wash.

It has been explained that *kās̲h̲ī-kārī*, "the art of floral decoration," has three main classes of decoration: *bel*, vines; *paudā*, plants and flowers, and *darak̲h̲t*, trees. Decoration applied to vessels may be subdivided in order to demonstrate how the source classes are applied. The first division relates to the color of the background of the decoration. A white background (*phūl-bhārvī*) is used with blue, or blue and turquoise decoration using flower decorations, and in this case the floral decoration becomes dominant. A colored background (*zamīn-bhārvī*), either

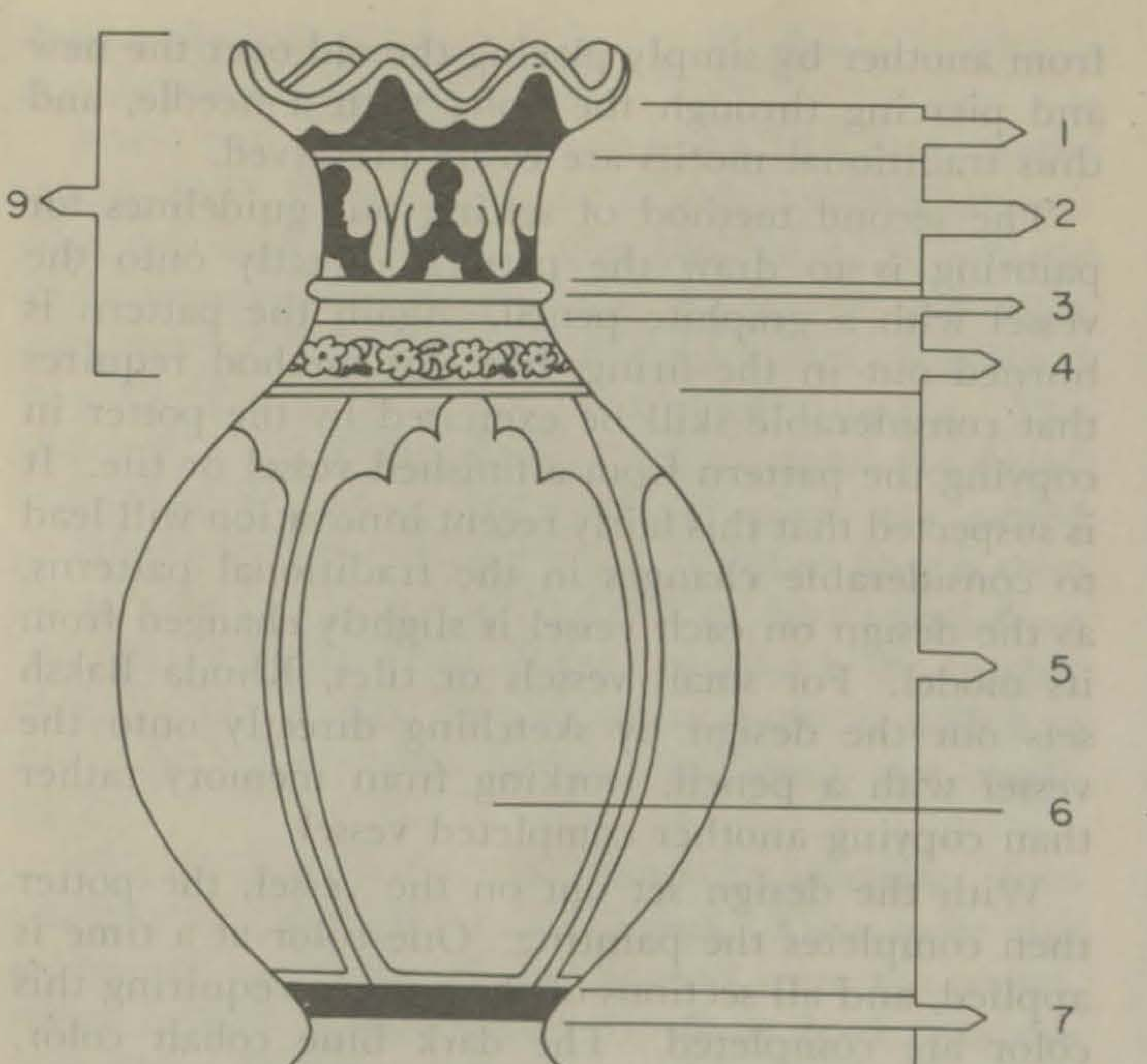


FIGURE 25.—Multan vase shape showing elements of brushwork decoration. (1=terminal border design, 2=standard border design, 3=relief band with lines (*likkā*), 4=border design (*bel* or *paudā*); 5=main section of decoration (*gul*) with panel, 6=panel (*mihrābī*), 7=wide band of color (*gola*) dividing (5) and (8), 8=foot (*kāp*), 9=top section of decoration (*paṭṭi*) with borders.)

of turquoise (*sabzī zamīn-bhārvī*), with the motifs in blue and white, or of blue (*lajvārd zamīn-bhārvī*), with white and sometimes also turquoise motifs, produces a dominant background. With a white background the motifs must be painted as positive applications; with a colored background the motifs, if white, are negative because the background itself is painted.

The vessel to be decorated is divided into distinct areas. The divisions for a closed form, such as a vase or bottle, are shown in Figure 25. Such forms are divided into three major sections: the top of the form, neck and rim, decorated with borders (*hāshiyā*) of repetitive horizontal motifs, or continuous lines (*likkā*); the central area (*gul*, "section," normally this word means "flower" in Urdu) with panels (*mihrābī*) of floral motifs repeated around the vessel,

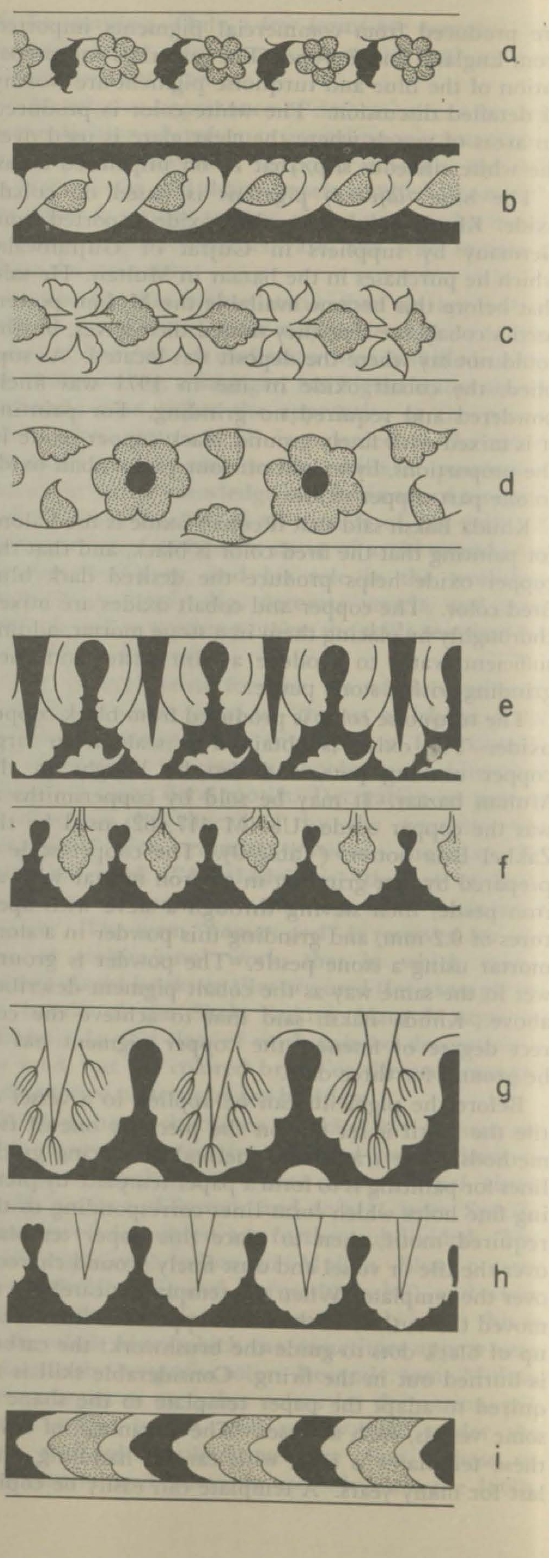


FIGURE 26.—Typical Multan border designs for brushwork decoration: *a–d*, intermediate borders; *e–f*, for neck of vases and other closed vessels; *g–h*, for base of closed vessels; *i*, terminal border. (From original drawings by master potter Khuda Baksh of Multan. Black=cobalt blue; stippled=turquoise; white=white.)

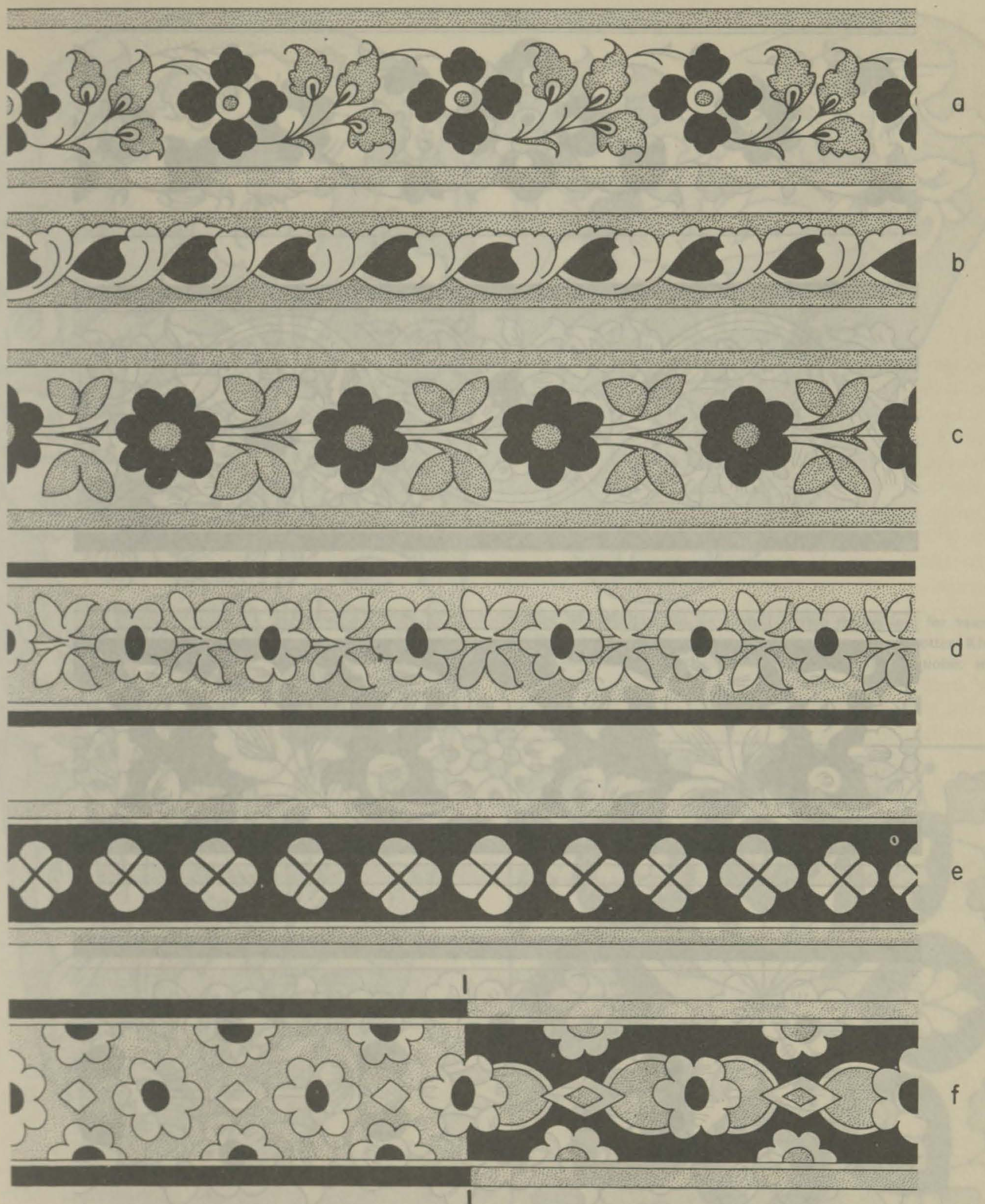


FIGURE 27.—Multan border designs for brushwork decoration: *a*, flower pattern; *b*, chain vine pattern; *c*, vine pattern; *e*, *f*, bangle flower patterns. (From original drawings by master potter Khuda Baksh of Multan. Black=cobalt blue; stippled=turquoise; white=white.)



FIGURE 28.—Multan border designs for brushwork decoration, used for tile panels or large vessels. (From original drawings by master potter Khuda Baksh of Multan. Black=cobalt blue; stippled=turquoise; white=white.)

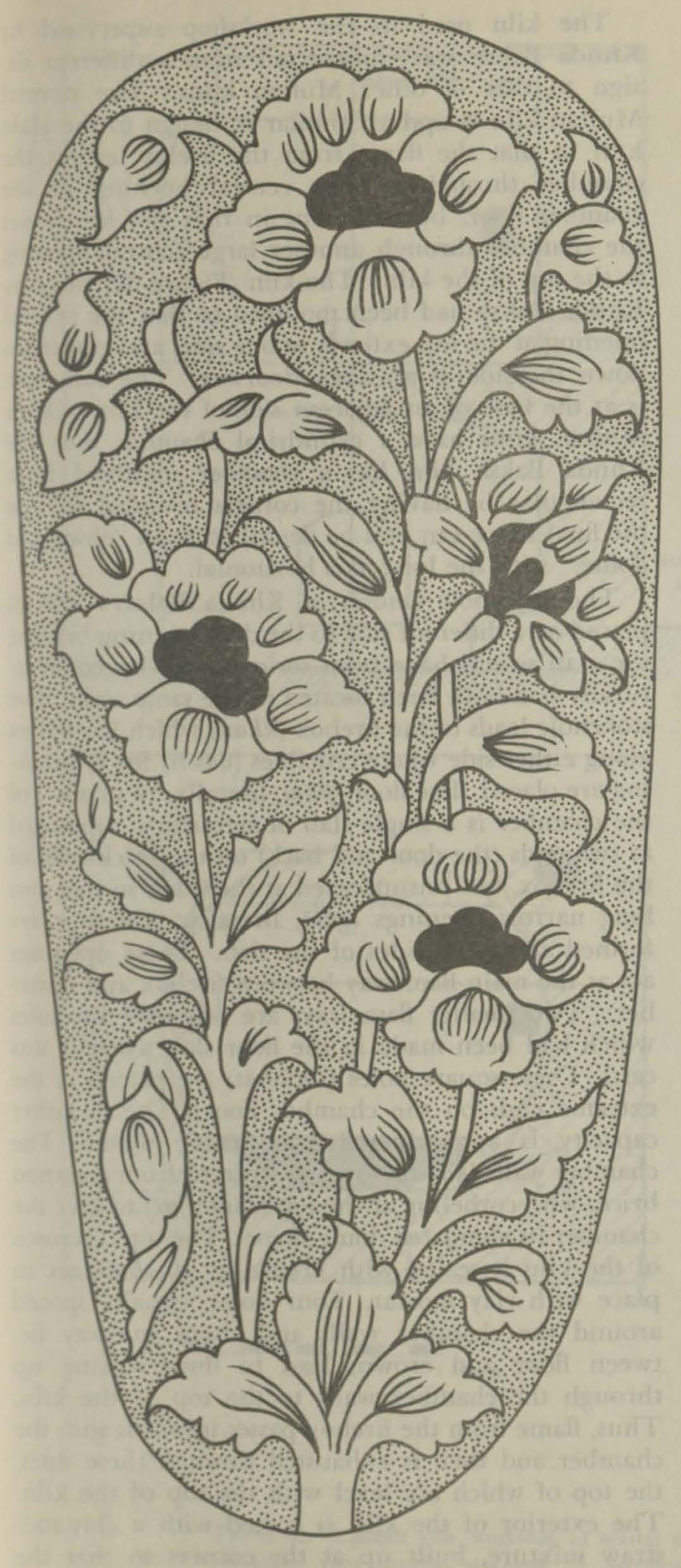


FIGURE 29.—Multan *gul,* or central section decoration, for vases or similar vessels. (From original drawing by master potter Khuda Baksh of Multan. Black=cobalt blue; stippled=turquoise; white =white.)

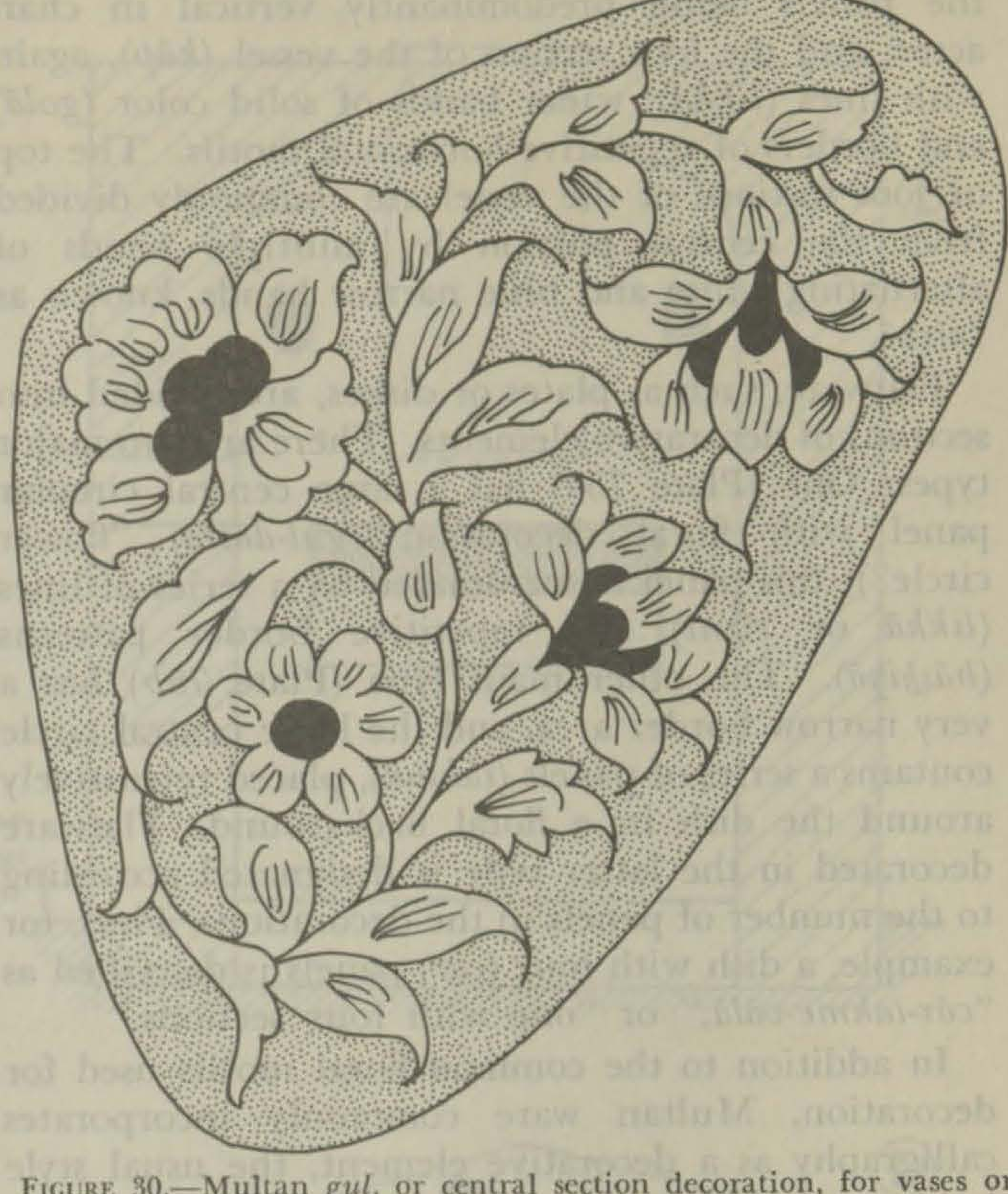


FIGURE 30.—Multan *gul,* or central section decoration, for vases or similar vessels. (From original drawing by master potter Khuda Baksh of Multan. Black=cobalt blue; stippled=turquoise; white =white.)

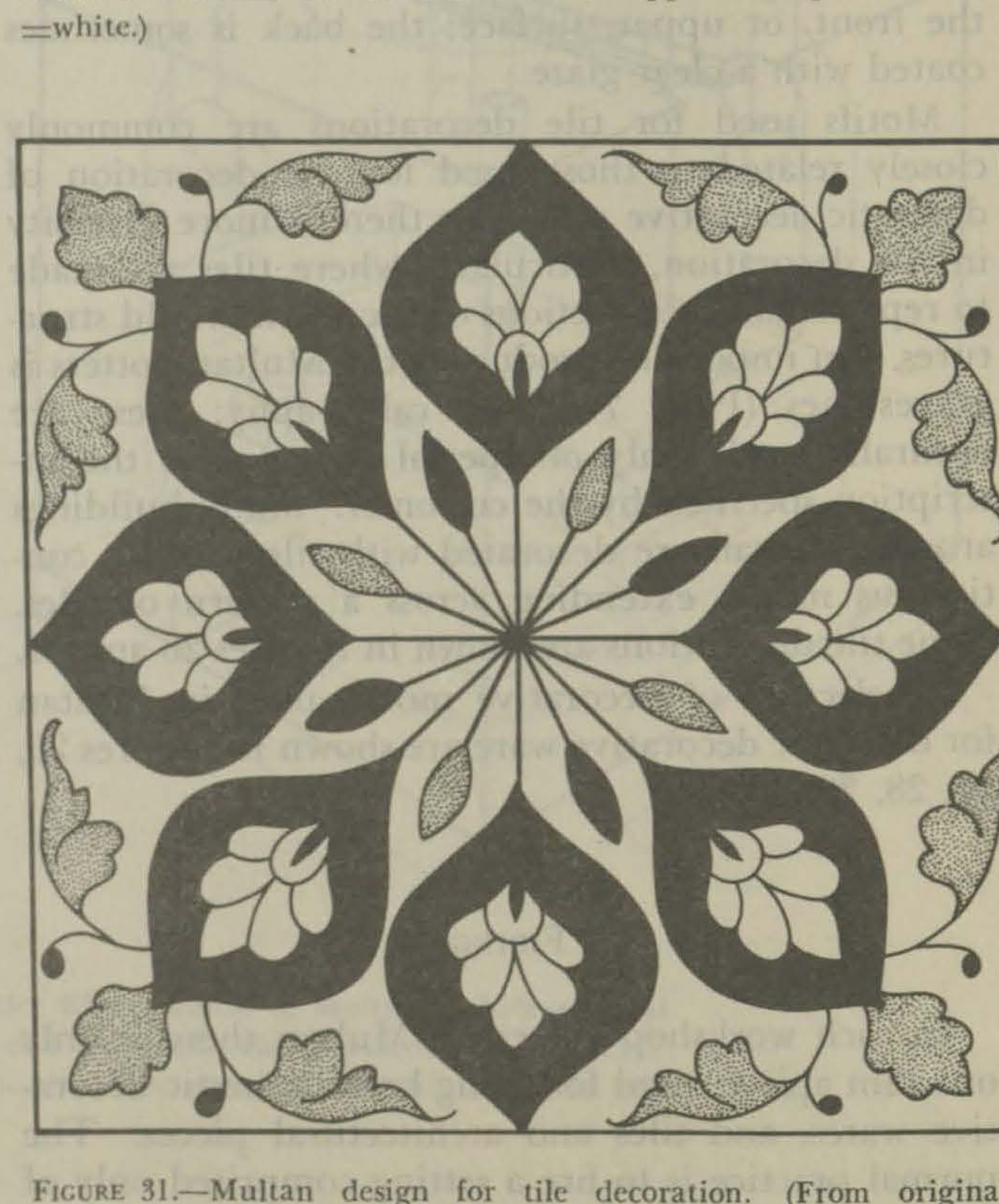


FIGURE 31.—Multan design for tile decoration. (From original drawing by master potter Khuda Baksh of Multan. Black=cobalt blue; stippled=turquoise; white=white.)

the panels being predominantly vertical in character; and the foot section of the vessel (*kāp*), again with lines (*likkā*), wider bands of solid color (*golā*) and borders of repetitive horizontal motifs. The top or foot sections of the vessel are commonly divided from the central portion by multiple bands of alternating white and blue narrow bands, known as "*cīrnī.*"

Flatware, such as plates or dishes, are divided into sections of decorative elements. There are two major types: One (Plate 75*a*) has a large central circular panel with floral decoration (*gul-dāirā*, "flower circle"); this panel is surrounded by a series of lines (*likkā* or *cīrnī*) and repetitive border patterns (*hāshiyā*). The other main type (Plate 75*b*) has a very narrow border area, and the large central circle contains a series of panels (*takmā*), placed repetitively around the dish in a floral background. Flatware decorated in the latter style is designated according to the number of panels in the decoration. Thus, for example, a dish with four (*cār*) panels is described as "*cār-takme-vālā,*" or "one with four sections."

In addition to the common floral motifs used for decoration, Multan ware commonly incorporates calligraphy as a decorative element, the usual style being to incorporate a verse from the Qur'an or simply the word "Allah." Dishes are only decorated on the front, or upper, surface; the back is sometimes coated with a clear glaze.

Motifs used for tile decorations are commonly closely related to those used for the decoration of domestic decorative ware, but there is more diversity in tile decoration, particularly where tiles are made to replace damaged sections of tile work on old structures. An important product of the Multan potters is gravestones (Plate 76) with calligraphy; these are naturally made only on special order, with the inscription specified by the customer. Many buildings around Multan are decorated with tiles having continuous motifs extending across a pattern of tiles. Some tile decorations are shown in Figures 28 and 31.

A selection of decorative motifs used in Multan for domestic decorative ware are shown in Figures 26, 27, 28, 29, 30.

FIRING

In each workshop visited in Multan there is only one kiln apiece, used for firing both domestic decorative wares, and tiles and architectural pieces. The normal practice is to fire a setting comprised only of tiles, or only domestic wares, but not the two mixed together.

The kiln used in the workshop supervised by Khuda Baksh was constructed from a different design to that of other Multan kilns. The normal Multan kiln is updraft similar in design to the Hala kiln in that the flame from the firebox enters the chamber through a large central opening in the chamber floor, but different in that the fire leaves the chamber through another large central opening at the top of the kiln. The kiln (Figure 32) built by Khuda Baksh had been modified so that the central opening at the top extends to one side, and continues down the side as an open doorway. The stokehole is at the base of an adjacent side of the kiln. Other Multan kilns have a cylindrical chamber, but the Khuda Baksh kiln has a chamber modified from rectangular by having the corners rounded so that the final shape can best be described as an "elongated dome," with the long axis horizontal.

The stokehole (*morī*) of Khuda Baksh's kiln is placed on a different side to the door opening because the wall would have been seriously weakened structurally had both been located in the same wall. The stokehole leads to the firebox (*khau*) which has ledges along either side where crucibles (*daurī*) for frit making are placed. The floor (*phaṭ*, literally, "a plank") of the chamber is a single slab of refractory, supported at two ends (the door and back) on the brickwork of the firebox, but unsupported at the sides, so that two long narrow openings (*galā*, literally, "throat") are formed along the sides of the slab. These openings act as the main flameway between firebox and chamber. Two smaller flameways are provided by holes which had been made in the floor slab when it was cast. These square holes (*dhū-kas*) are placed at the extreme ends on the chamber floor. The chamber capacity is approximately one cubic meter. The chamber walls (*kandhī*) are constructed from common brick, with corbeling at the top (*ḍāṭ-tajjar*) to give the chamber its elongated dome shape. The top or crown of the kiln is sealed with fired tiles (*dhaknā*) set in place with clay mortar. Four holes, equally spaced around the chamber walls and about midway between floor and crown, lead to flues passing up through the chamber walls to the top of the kiln. Thus, flame from the firebox passes upwards into the chamber and then is exhausted through these flues, the top of which are level with the top of the kiln. The exterior of the kiln is coated with a clay-and-straw mixture, built up at the corners so that the completed kiln is square on exterior plan.

The setting techniques for tile and domestic wares are quite distinct one from the other. Tiles are set vertically standing on edge. Two small pieces of plastic clay are fixed to one edge of the tile, and

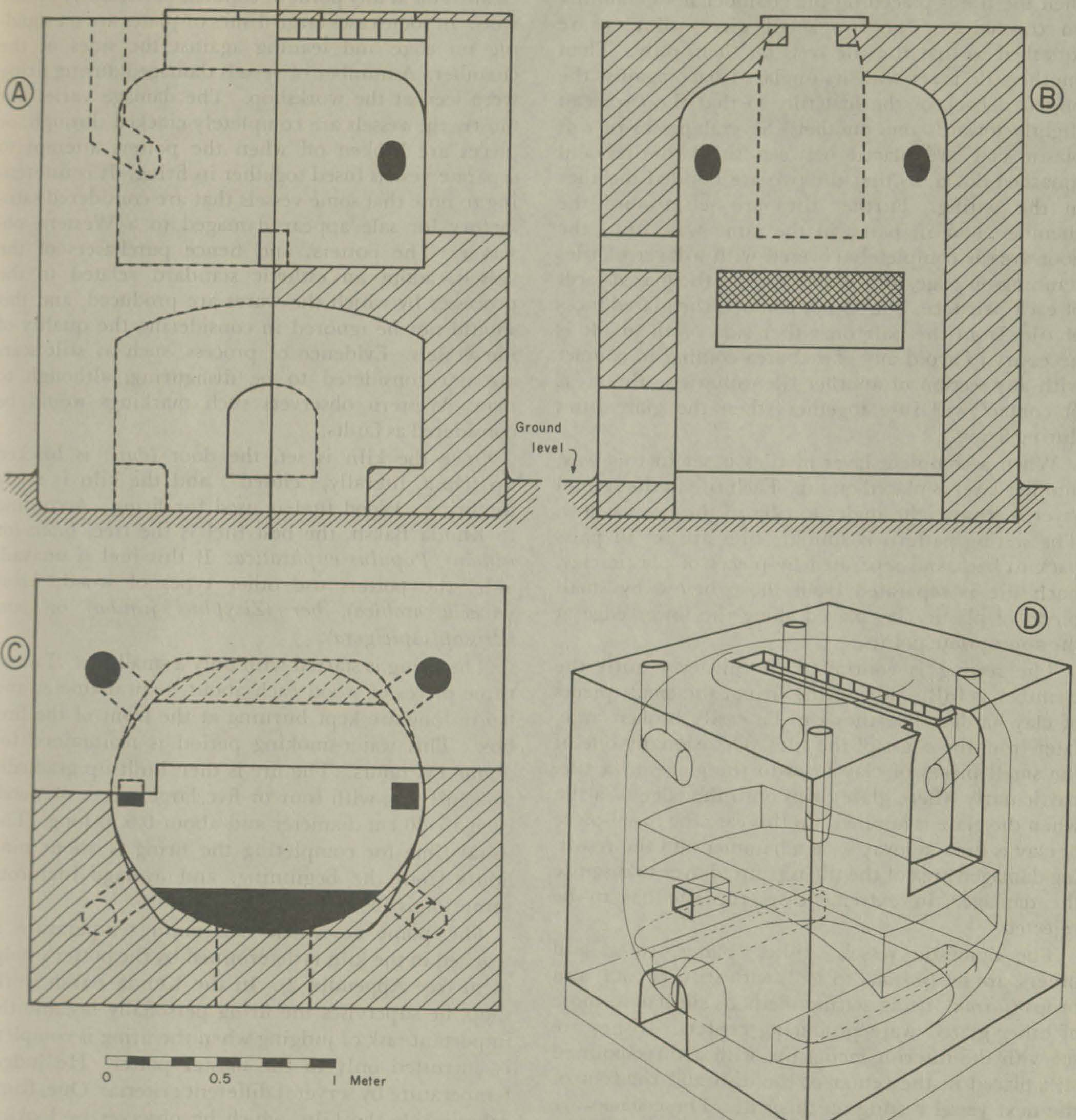


FIGURE 32.—Updraft kiln, workshop of master potter Khuda Baksh of Multan: *a*, half-sectional elevation, view towards stokehole; *b*, sectional end elevation, view towards door; *c*, half-sectioned plan, sectioned at floor level; *d*, perspective view showing internal layout of kiln (stokehole at lower left, door upper right).

then the tile is placed on the chamber floor standing on this edge. The two small pieces of clay are squashed so that the tile rests on them only. Then another tile is set with its unglazed back against the unglazed back of the first tile, so that the two lean slightly towards one another. Several pieces of soft plastic clay are placed between the two tiles and squashed down, so that the two are bonded together in the setting. Further tiles are set around the chamber floor in pairs, in the same way, until the floor area is completely covered with a layer of tiles standing on edge, alternating so that the glazed faces of each pair face, but do not contact, the glazed faces of tiles from the pair on either side of them. It is necessary to avoid any glazed area coming in contact with any section of another tile, otherwise the areas of contact will fuse together when the glaze fuses during firing.

When a complete layer of tiles is set in this way, another layer is placed on top. Each tile in the second layer is set at right angles to tiles in the layer below. The setting pattern is similar; tiles are set in pairs back to back and separated by pieces of plastic clay. Each tile is separated from those below by small pieces of plastic clay placed along the lower edge at the appropriate points.

The setting is continued in this way until the chamber is full. During the firing, the small pieces of clay harden, but they can be easily broken away later from the edges of the tiles. Occasionally one of the small pieces of clay fuses to the glaze on a tile, particularly where glaze drips onto the edge of a tile when the glaze is applied. In this case the fused piece of clay is broken away with a hammer and the resulting damaged area of the tile is painted over to disguise the damage. In extreme cases the tile has to be rejected.

The domestic vessels, dishes, plates, vases, and others, are set (*joṛnā*, "to set") with stilts (*sipāvī*) and props (*farmā*), using setting methods similar to those of other glazed ware producing centers. Dishes are set with the interior facing up, with a three-pointed stilt placed in the center of the dish and the foot of the next vessel resting on this stilt. These stacks are continued upwards from the floor to the top of the chamber. The use of three-pointed stilts resting on the glazed surface of dishes and plates means that the glaze fuses to the stilt, which has to be broken away after the firing, leaving three characteristic scars on the face of each vessel. These scars are painted over with paint which matches the colors of the decoration or glaze, but are still evident on fired pieces. Vases and other vessels of appropriate shape are set resting one on top of another, with the glaze cleaned off at any point of contact, particularly on the rims. In some cases large dishes or plates are set standing on edge and leaning against the sides of the chamber. A number of vessels damaged during firing were seen at the workshop. The damage varies but mostly the vessels are completely cracked through, or pieces are broken off when the potters attempt to separate vessels fused together in firing. It is interesting to note that some vessels that are considered satisfactory for sale appear damaged to a Western observer. The potters, and hence purchasers of the vessels, adopt an esthetic standard related to the processes by which the wares are produced, and this should not be ignored in considering the quality of the vessels. Evidence of process, such as stilt scars are not considered to be disfiguring, although to many Western observers such markings would be considered as faults.

Once the kiln is set, the door (*darī*) is bricked up (*band*, literally, "closed") and the kiln is ready for firing. Wood fuel is used for firing. According to Khuda Baksh, the best fuel is the tree, *bhān* (or *ubhān*), *Populus euphratica*. If this fuel is unavailable, the potters use other types of wood: *kīkar* (*Acacia arabica*), *ḇer* (*Zizyphus jujuba*) or *janḍ* (*Prosopis spicigera*).

The firing is started with only a small fire. Two or three pieces of wood each about 8 cm diameter and 0.6 m long are kept burning at the front of the firebox. This water-smoking period is maintained for about 1½ hours. The fire is then built up gradually to a full fire, with four or five large pieces of wood, each 15–20 cm diameter and about 0.6 m long. The usual time for completing the firing is about nine hours from the beginning, and average fuel consumption is 400 kg of wood.

The point at which maximum temperature is reached in the kiln is determined by the potter's judgment (see Appendix 2). In the Khuda Baksh workshop, he supervises the firing personally because the important task of judging when the firing is complete is entrusted only to the master potter. He judges temperature by serveral different criteria: One, flame color inside the kiln, which he observes by looking through a spyhole in the door of the kiln. If, during the course of the firing, he observes that the temperature varies in different parts of the chamber he adjusts this by varying the position of fuel in the firebox, to cause parts of the firebox, and hence the chamber, to become hotter and hence even the temperature is estimated also from the appearance of vessels inside the chamber. The degree of glaze fusion is estimated from observation of the reflectance

and glossiness of the glazes. He said that when the correct temperature is reached, then the glazes became "mirror-like" and the vessels forms are reflected on the glazed surface of others. He also observes the colors of the flames emerging from the flues at the top of the kiln.

When it is judged that the finishing temperature has been reached the potter terminates the firing by ceasing stoking. No more wood is added, but the wood already in the firebox is allowed to burn down until only ashes are left. Then bricks are used to seal the stokehole, and soft clay is plastered over the bricks to prevent cold air drafts into the kiln. The spyhole is also sealed with soft clay. The top flues are left open to allow heat to slowly escape from the chamber. After the firing is finished, the kiln is allowed to cool for 24 to 36 hours, and then some bricks are removed from the top of the kiln door. Usually the kiln is left for another two days before the ware is removed.

HALA, SIND

This section is compiled from unpublished field notes of Hans Wulff recorded in December 1967, Don Godden in 1967, and more detailed interviews and observations by Owen Rye in 1971.

Tehtown of Hala is 50 km north of Hyderabad, in Sind. There are village potters in the area, who make unglazed earthenware for domestic use, but these earthenware potters are not included in the study. This study is confined to potters and tile makers making glazed ware.

Both in 1967 and 1971 there were said to be eight workshops in Hala producing glazed ware. The potters came from five different families, and in these workshops they are all full-time workers, not seasonal, although it was said that production slows in the rainy season during July and August due to the difficulties of drying ware and firing when the weather is wet.

The major output of the Hala workshops is tiles, but a limited amount of hollow ware pottery is also made. Most of the styles of hollow ware are of recent introduction, although two shapes, the waterpot and the hookah (*cilam*), are adapted from the traditional unglazed earthenware. The potters said that most of the tile shapes and decorations are taken directly from the traditional style, and that these have not changed recently.

The hollow ware pottery is usually made or sent to dealers, from both the local bazaars and from Hyderabad, and only a small proportion of this ware is made on order. The tiles are made both on order and for sale to dealers who come to the workshops to buy. No assessment of the total output of the workshops could be obtained.

The potters of Hala are descended from traditional potter families, and usually the eldest son of a potter is expected to also become a potter. This son learns by working with the potter; it is expected that this working relationship will continue and that the son will not establish a workshop in competition with the father, but will wait until the father is ready to retire and then take over the father's business. Sometimes women of the potter's family assist with parts of the work, such as moving ware for drying, or, less commonly, with decoration by painting.

Materials Gathering and Preparation

Potters who were interviewed, said that they buy clay from dealers rather than digging the material themselves. The clay is brought to the workshop either on donkey carts or carried in sacks by donkeys. Potter Shafi Mahommed, interviewed in 1971, buys his clay from a dealer who delivers it in sacks carried by donkeys. He buys 100 donkey loads a month on average, each load being one maund (about 36 kg) of clay. The cost of clay is 4 annas a load (25 paisa), which means that clay costs 25 rupees a month. The clay is dumped in a corner of the potter's courtyard, where it is left to dry in the sun until used.

Two people, the potter and his son, are operating this workshop, and it is necessary to make a batch of body each day. Dry clay is selected from the stockpile and the lumps are broken up, so that no pieces remain larger than 2–3 cm across. The potter uses an iron bar 25 cm long and 2.5 cm diameter to break up the clay (*bhañanu*). The clay is not sieved. The clay is then slaked (*garaṇu*) in a steel drum. This drum is set in the ground, so that only the top 15 cm protrude above ground level. The drum has interior dimensions of 1 m in height and 60 cm in diameter. The potter said that before steel drums became available the slaking was done in a pit dug in the ground, the dimensions of the pit being similar. Broken lumps of clay and waste clay (*ṭhiker*) recovered from the pottery are placed in the drum to a level about 15 cm below the top of the drum and then the drum is filled with water (*pāṇī*). The clay is allowed to slake (*garaṇu*) for one day in the summer or two in the winter.

The body is made without admixture of any non-

plastics. Water is not removed from the top of the slaked clay; the potter scoops clay from the drum with his hands and places it on an area reserved for the purpose in his courtyard. This is done late in the afternoon, and only enough clay for the next day's work is placed out to dry to plastic condition. Any grit (*kakar*) found in the clay while it is being placed out to dry is removed by picking it out with the fingers. After drying overnight, the body is prepared for use the next morning by foot-kneading (*lat hanaṇu*). After foot-kneading the potter again inspects the clay for pieces of grit and removes any particles by hand.

Inspection of a sample of this clay (USNM 417,127) showed that the grit consists mainly of shells of freshwater snails and land snails. The freshwater snails were identified by Dr. Joseph Rosewater of the Smithsonian Institution, as from the family Viviparidae. The shells are often complete, less than 0.5 cm in length. Particles of shell from an unidentified land snail are also present in lower concentration; these particles are also 0.5 cm and less in size. The concentration of shells in the clay is of the order of 1 percent by weight of shells, but examination of fired tiles and pottery from Hala failed to show remnants of pseudomorphs of the shell, at least on the exposed surfaces, indicating that the relatively crude method of removal is efficient. The final process of grit removal is followed by hand-kneading (*malaṇu hath sā*). After this kneading the body is ready for use.

Forming Techniques

The making of hollow ware pottery is not sufficiently distinctive in technique from methods described elsewhere (p. 80) to warrant a detailed description. The ware is formed by throwing initial shapes on a potter's wheel and then turning to final shape. Both the pit-wheel and stick-spun ground wheel are in use, but the potters could not say whether one type came into use more recently than another. Only one type is in use in any specific workshop, the two types are not intermixed.

Tiles are made by several different procedures; the procedure in any workshop is standard, but different workshops use different methods. Shafi Mahommed uses, perhaps, the most direct method. After kneading by hand, a lump of clay is flattened directly on the floor of the workshop, to a thickness and size appropriate to the size of tile being made. The most common size is a square of 30.4 cm (12×12 in) after firing. The potter has sheet metal templates for each shape and size of tile. These templates are oversize in order to compensate for the drying and firing shrinkage of the clay. The shape of the tile is marked out on the surface of the clay blank, using the appropriate template. The potter then cuts the tile from the blank, using a steel-bladed knife. After the tiles have dried to leather hard the surface is smoothed by rubbing with a wet cloth. At this stage the back of the tile is incised with a cross-hatched pattern so the mortar will grip the tile when it is finally set in position on a building. The tiles are then stacked on edge to dry in the potter's courtyard. It was noted that most of the tiles warp during the final stage of drying. This warping is disregarded by the potter, who said that mild warping is acceptable to both the builders, who would set the tiles, and to the customers, who buy them. Most of the warping could be attributed to the method of drying, stacking semi-dry tiles on edge, rather than drying them flat on a plane surface.

For some complex shapes Shafi Mahommed has experimented with forming the tiles in plaster molds, and this technique of plastic pressing is used for some shapes. The plaster is bought from industrial suppliers, but he had previously made his own plaster from gypsum (*cirorī*) obtained from Sehwan Sharif. The gypsum is calcined in the firebox of the kiln during a firing and then removed and crushed, and ground in a stone quern. Shafi Mahommed could not comment on the antiquity of this process in the area, but said that this gypsum was formerly the source of plaster for use by builders.

Potters in Hala also use a tile molding frame for standard square or rectangular tiles. This was described by Don Godden in his 1967 unpublished field notes (ATPR, 1967–1971) and a brief summary is presented here. The frame has a flat wooden base with a raised lip of steel around the edges. The height of the sheet steel border corresponds to the thickness of a tile and the dimensions of the base are such that four tiles can be formed by pressing plastic clay into the mold, scraping the top off smooth, and then cutting the clay to produce four tiles. The top of the tile surfaces is scraped smooth with the edge of a straight piece of wood, guided by the straight steel edges of the molding frame. Another piece of wood has three steel nails driven through it in such a way that the points project the thickness of a tile to be cut. Using the two outer nails as a guide along the sides of the frame, the potter cuts the tiles to shape with the central nail. At the same time the two outer nails free the sides of the tiles from the steel edges of the frame. When the tiles are dried sufficiently they are removed from the frame and stacked to dry.

Apart from the square and rectangular tiles, the

potters also make other traditional shapes of solid tile, as well as perforated tiles for screens. The perforated tiles are made by cutting the outline to a template and then cutting out the central portions with a fine-bladed knife when the tile dries to leather hard. Some of the common tile shapes are shown in Figure 33.

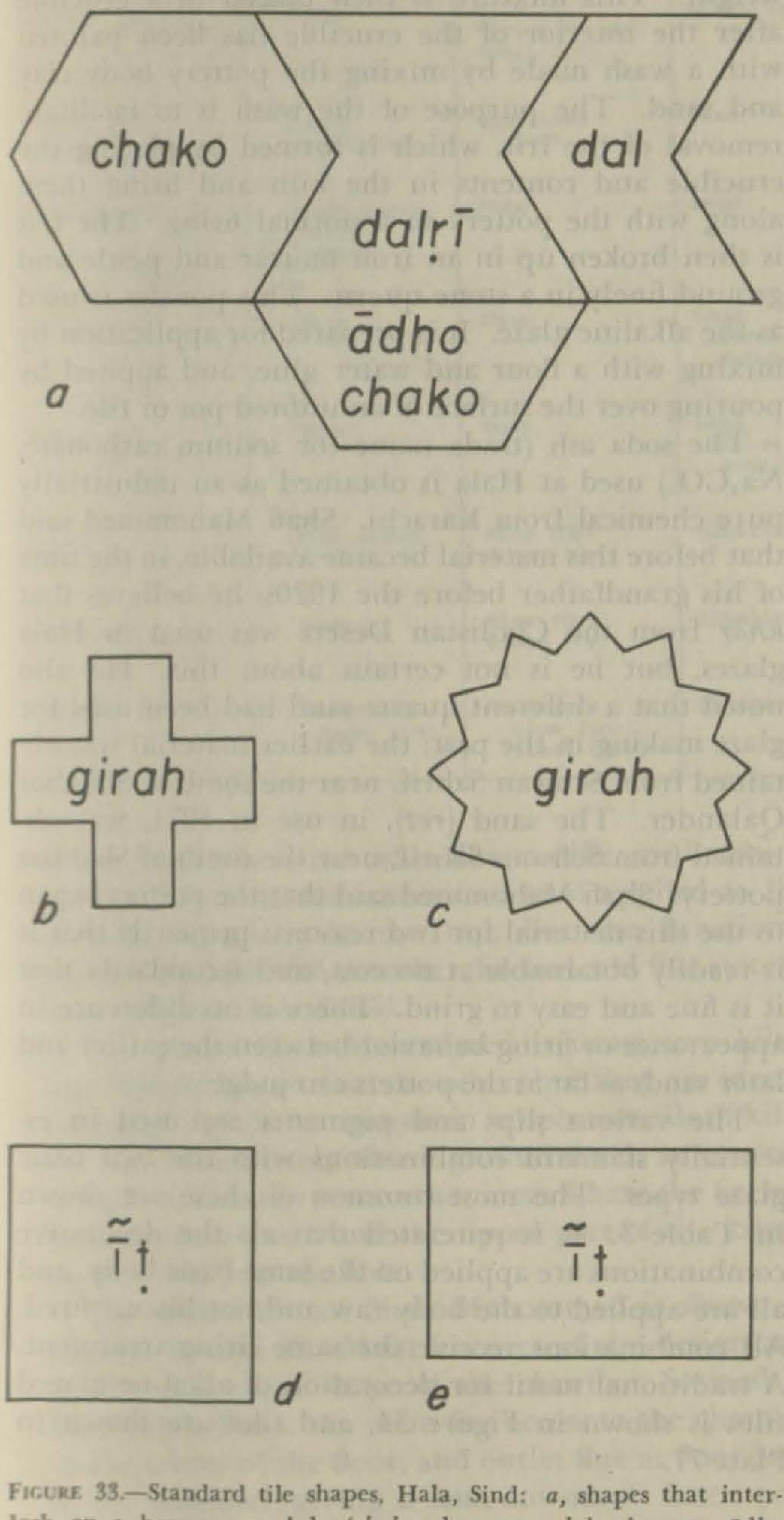


FIGURE 33.—Standard tile shapes, Hala, Sind: *a*, shapes that interlock on a hexagon module (*chako*=hexagon, *dal*=chevron, *ādho chako*=half a hexagon, *dalri*=constricted hexagon); *b*, *c*, shapes used for emphasis in mosaic designs (*girah*=shapes infrequently used for emphasis in a design with *b* representing a Pommée cross and *c* a 12-pointed star); *d*, *e*, shapes that are used in repeating modules (*īt*=brick or square shape as the term would be interpreted by a Western bricklayer with *d*, a square, and, *e*, a rectangle). (See Plate 77.)

Slips, Glazes, and Decoration

A number of different slips are used. These can conveniently be divided into two groups: first, the slip for alkaline glazed ware; and second, the slips for lead glazed ware.

The slip for alkaline glazed ware is made from flint (*pathar*, literally, "stone"). The flint is bought from dealers, who obtain it from a location near Sukkur. The material bought from dealers is typically in the form of large nodules weighing between 1–10 kg. The weathered surface of the nodules has pockets of iron-rich material which are scraped away by the potter and discarded before the rest of the stone is prepared. The first stage of preparation is calcining. Flint nodules are placed at the floor of the kiln during a firing, and removed after the firing. This calcining makes the flint easier to crush. Initial crushing is done by breaking up the flint with an iron mortar and pestle (*imām-dastā*). The resulting material, 0.2 mm and finer, is then ground in a quern to a fine powder. This powder is mixed with a thin flour and water glue for application to the pottery or tiles.

For lead glazed ware a number of slips are used. A white slip is based on a white firing clay. The clay is slaked in a small drum and when completely broken down is transferred to a hemispherical iron dish (*tagārī*). At this stage the slip is very thick. Water is added until the slip (*rabṛi*) is fluid enough for application. The slip is then thoroughly stirred by hand, and a little more water added. The slip is sieved through a piece of cotton cloth to remove all particles of grit. After sieving, soda ash (Na_2CO_3) is added to the slip in the proportions of $\frac{1}{16}$ of a seer of soda ash to 10 seers of slip, which is about 5.7 liters (1 seer approximately equals 1 kg). This addition of soda ash acts as a deflocculant, causing the clay to settle. This allows excess water to be poured off the slip and causes the slip to dry more quickly after application.

A pinkish brown slip is made from a yellow ochreous clay obtainable commercially. This clay is imported from Gujrat, in the Panjab, where it is widely available. Panjabi potters also use it as a slip, usually as a red slip on unglazed ware. The clay is purchased in powder form and is prepared for use as a slip at Hala by the same methods used for the white slip.

A black slip is made by adding iron oxide to the white clay, normally used as the white slip. The proportions are one part or 20 percent by weight of red oxide, hematite, to four parts, or 80 percent by weight, of white clay. The iron oxide is added to the slaked white clay and then the black slip is prepared

as described above for the white. The proportions of iron oxide and clay in the slip are sometimes varied to give a darker or lighter colored slip.

A green slip is also used with lead glazes. This is made by mixing copper oxide with the white clay just described; proportions are one *chiṭānk* of copper oxide, that is $\frac{1}{16}$ of a seer, to one seer of white clay; or one part of copper oxide to 16 parts of clay by weight.

These four slips, when used under a clear lead glaze, give white or sometimes yellow, pink-brown, black, and green colors. It must be noted that these slips are only used with the lead glazes, and slips for lead glazed and alkaline glazed ware are not interchangeable.

Apart from the slips, colored pigments are used with both types of glaze. With the lead glazes, red iron oxide is used for brushwork. It is applied over white slip, and when fired with a clear lead overglaze it gives black. With the alkaline glaze three pigments are used: cobalt oxide to give blue, copper oxide to give turquoise, and copper oxide mixed with lead and chromium oxide to give green. At the time of the interviews all these oxides were obtained from commercial suppliers who imported the oxides. According to the potter Shafi Mahommed the oxides were formerly obtained in less pure form from local sources, but he could give no further details. All oxide pigments are used in the same way, first finely ground in a stone mortar and pestle and then mixed with water and painted on with camel-hair brushes made by the potter. The technology of the pigment preparation and use is extremely simple, but the skill displayed by the master painters in applying even washes and lines is of a very high order.

The lead glazes used by Shafi Mahommed are either bought prepared from suppliers in Karachi or are prepared by the potter. He differentiates these as two types of glaze, but said that they both fire to an identical appearance at the same firing temperature. This was confirmed by examination of pottery made with both types. The potter in fact uses them interchangeably. For the glaze, which he prepares himself, the potter uses red lead, bought from suppliers, and sand obtained from a deposit near Hala. Examination of the sand showed it to be almost pure quartz sand, with no visible mineral impurities. The sand is prepared by grinding finely in a stone quern (*cakki*). The powdered quartz and red lead are then mixed in the gravimetric proportions of 11 parts red lead and 5 parts sand with the normal batch being $2\frac{3}{4}$ seers of red lead, $1\frac{1}{4}$ seers of sand. This mixture is then placed in an unfired crucible made from the ordinary pottery body and fritted in the kiln during a firing. The frit is then crushed, ground in a quern, and is ready for application when mixed with water.

The commercial lead glaze is supplied as a powder ready for use and requires no preparation by the potter.

The alkaline glaze is made by mixing soda ash and the local quartz sand in equal proportions by weight. This mixture is then placed in a crucible after the interior of the crucible has been painted with a wash made by mixing the pottery body clay and sand. The purpose of the wash is to facilitate removal of the frit, which is formed by placing the crucible and contents in the kiln and firing them along with the pottery in a normal firing. The frit is then broken up in an iron mortar and pestle and ground finely in a stone quern. This powder is used as the alkaline glaze. It is prepared for application by mixing with a flour and water glue, and applied by pouring over the surface of an unfired pot or tile.

The soda ash (trade name for sodium carbonate, Na_2CO_3) used at Hala is obtained as an industrially pure chemical from Karachi. Shafi Mahommed said that before this material became available, in the time of his grandfather before the 1920s, he believes that *khār* from the Cholistan Desert was used in Hala glazes, but he is not certain about this. He also noted that a different quartz sand had been used for glaze making in the past; the earlier material was obtained from Schwan Sahrif, near the tomb of Shahbaz Qalander. The sand (*ret*), in use in 1971, was obtained from Sehwan Sahrif, near the tomb of Shahbaz pottery. Shafi Mahommed said that the potters began to use this material for two reasons: primarily that it is readily obtainable at no cost, and secondarily that it is fine and easy to grind. There is no difference in appearance or firing behavior between the earlier and later sands as far as the potters can judge.

The various slips and pigments are used in essentially standard combinations with the two basic glaze types. The most common of these are shown in Table 3. It is reiterated that all the decorative combinations are applied on the same basic body, and all are applied to the body raw and not biscuit fired. All combinations receive the same firing treatment. A traditional motif for decoration of alkaline glazed tiles is shown in Figure 34, and tiles are shown in Plate 77.

Firing

Kilns seen at three different workshops in Hala are basically similar in design, construction, and operation, although their size varies. The outside appearance of kilns from different workshops is dif-

TABLE 3.—*Classification of decorative combinations on glazed ware from Hala, Sind; all the glazed wares are of the same clay body and are fired in the same manner*

SLIP		PIGMENT	GLAZE
Overall coating	Brushwork patterns	Brushwork	
Flint	None	Blue (Co) Turquoise (Cu) Green (Cr)	Alkaline
White clay (fires yellow)	Black Pink-brown	Sometimes black	Lead
Black clay	Pink-brown White Green	None	Lead
White clay	None	None	Lead (fires yellow)
None	None	None	Lead (fires amber)
Flint	Pink-brown	Blue (Co) Green (Cr)	Alkaline
Flint	None	Blue (Co) Green (Cr)	Alkaline
Flint	Turquoise wash (Cu)	Sometimes blue (Co) (black rare)	Alkaline

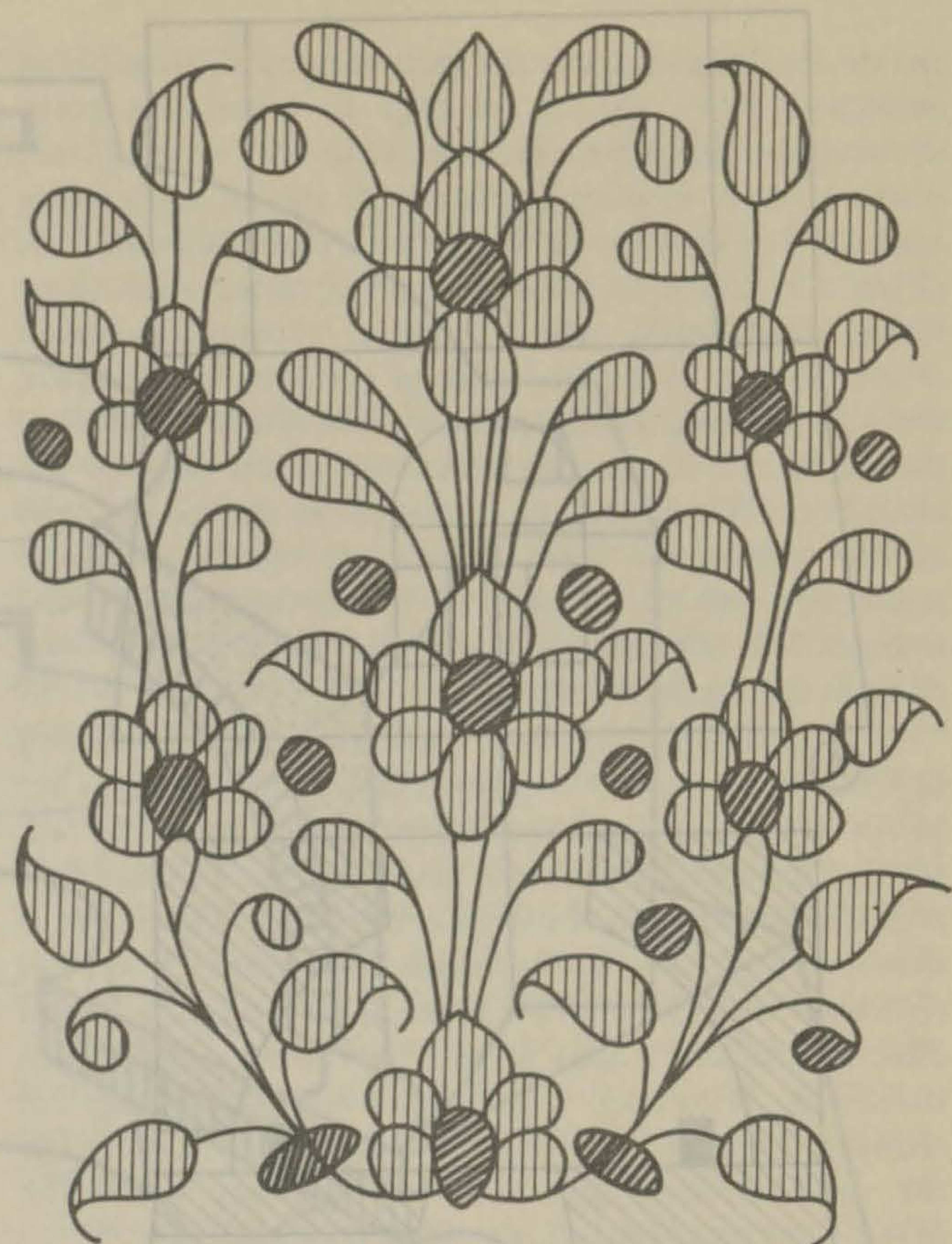
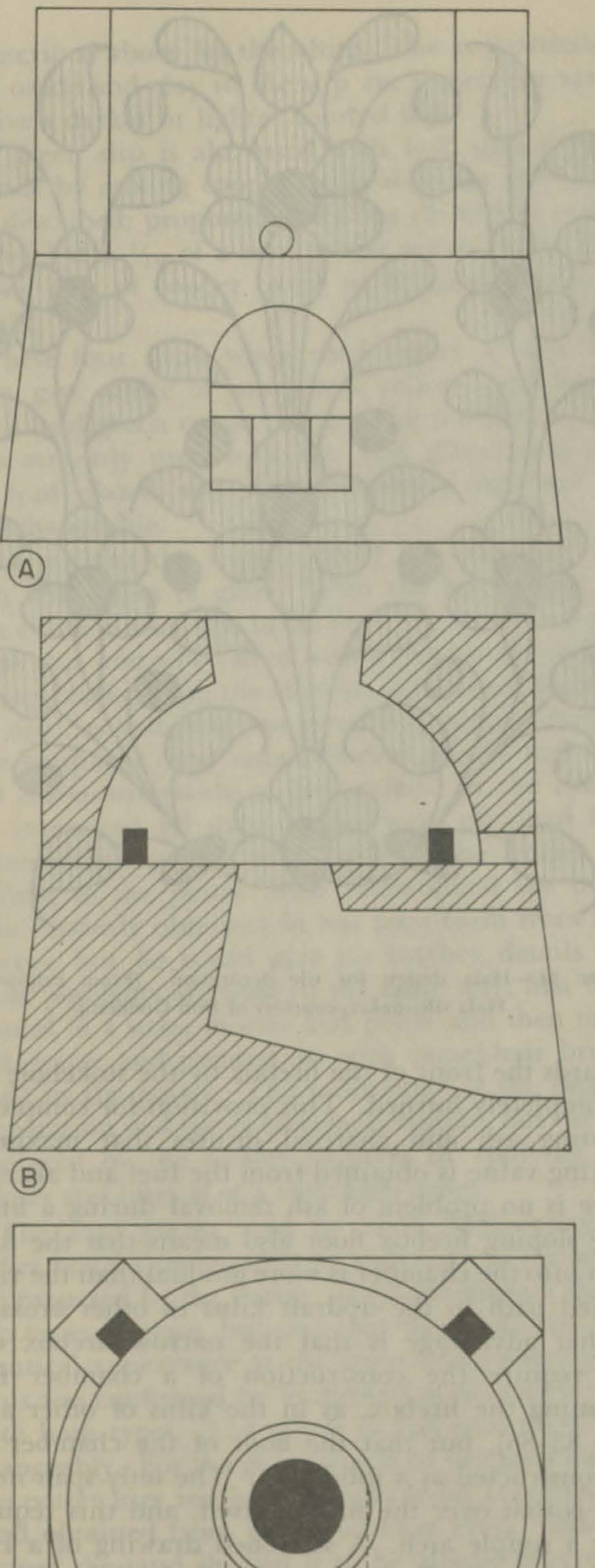


FIGURE 34.—Hala design for tile decoration. (From original by Hala tile-maker, courtesy of Don Godden.)

ferent from one to the other due to different finishing methods, such as the amount of mud applied to the outside, especially at the top; but the functional parts of the kiln, the chamber, firebox and flue system, vary only in minor detail.

The potter Shafi Mahommed is using two kilns, one slightly larger than the other, but they are identical except for the variations in proportion. Both kilns are built completely above ground level, in contrast to updraft kilns in some other areas where the firebox is partly excavated, and the upper part of the kiln is constructed over the hole.

The small kiln of Shafi Mahommed is shown in Figures 34 and 35. Main features of the design are: the hemispherical shape of the chamber, formed by building a dome; the main fire access to the chamber in the center of the floor, and outlet flue at floor level in the chamber, giving a semi-downdraft flame path in what is essentially an updraft kiln. The firebox is of a more sophisticated design than in other areas. The front opening, the stokehole, is almost twice as high as wide. The firebox itself is the same width as the stokehole. The floor of the firebox slopes upwards from front to back, so that as the fire burns ash falls towards the front of the firebox by the stokehole and is completely burned. This provision for completely burning ash and charcoal insures that maximum heating value is obtained from the fuel and also that there is no problem of ash removal during a firing. The sloping firebox floor also means that the flame path into the chamber is more gradual than the right-angled path in the updraft kilns in other areas. A further advantage is that the narrow firebox does not require the construction of a chamber floor spanning the firebox, as in the kilns of other areas (pp. 83–86), but that the floor of the chamber can be constructed as a solid unit. The only span necessary is that over the firebox itself, and this requires only a simple arch. A sectioned drawing of a Hala kiln shows the basic structure of the kiln (Figures 35, 36). In operation the kiln is not a simple updraft, but the flame path is semi-updraft. From the firebox, flame travels upwards through a central opening in the chamber floor. It passes up through an open area in the center of the setting, and is then diverted downwards along the chamber walls to four openings, or flues, in the chamber wall at floor level. These



flues lead to four chimneys equally spaced around the exterior of the kiln. The top of the chimney is either at, or slightly lower than, the level of the top of the kiln. These short chimneys incorporate a simple "damper" system. Tiles placed loosely over the top are moved to vary the draft at any one of the four chimneys, or in any necessary combination.

The kilns are built completely from unfired bricks (*ĩṭ*, "bricks"; *kaca*, unfired). Shafi Mahommed had built both his own kilns. He said that during the building no formwork is necessary. The unfired bricks support themselves in position when bonded with a thick slurry clay mortar. This bonding is strong enough to build arches and domes without any other support. In order to lay a brick in building a dome or arch, the worker dips one face of the brick in the clay mortar, holds it in the mortar until a coating about 1 cm thick builds up on the face to be bonded, and then presses this coated face into position against the existing brickwork of the structure. The brick is held in place for a few seconds until water has been removed from the mortar by the porous dry bricks. The newly laid brick is then released, and remains in position. This bonding is sufficiently strong to hold even a vertically laid brick. When a kiln is newly built the first few firings produce extensive cracking of the structure due to firing shrinkage of both the bricks and mortar. The cracks are repaired by filling them with clay after each firing. When the structure has stabilized it is completely coated on the outside with a thick layer of mud-and-straw plaster, to provide maximum insulation. Occasionally further cracks appear in the structure; these are also repaired with a mud-and-straw mixture.

The fuel used by Shafi Mahommed is *bābul* (*Acacia arabica*), also known in the vernacular as *kīkar*. This acacia tree provides a variety of other usable products (Parker, 1918). The potters prefer *bābul* to other wood fuel available, such as, *bhan* (*Ceopulus euphralica*); *lei*, (*Tamarix dioica*); *thali*, (*Sapindus mukorossi*); *lāwa;* and *sīrī*. *Bābul* is preferred, according to Shafi Mahommed, because it burns with a clear flame, whereas the alternative fuels burn with a smokey flame. The fuel is cut to a length of about 1.2 m, but is not split. It is burned as round logs varying from 5–15 cm in diameter. Fuel consumption is 6 maunds, or about 220 kg, per firing in the small kiln and 10 maunds, or about 360 kg, per firing in the large kiln. Cost of the fuel is 2.50 rupees per maund.

Kilns are set from the top. The potter climbs down

FIGURE 35.—Updraft kiln for glazed vessels and tiles, Hala, Sind: *a*, elevation, view toward stokehole, showing brick "firebars" as they would be in position in the stokehole for firing; *b*, sectioned side elevation; *c*, plan (firebox indicated by broken lines).

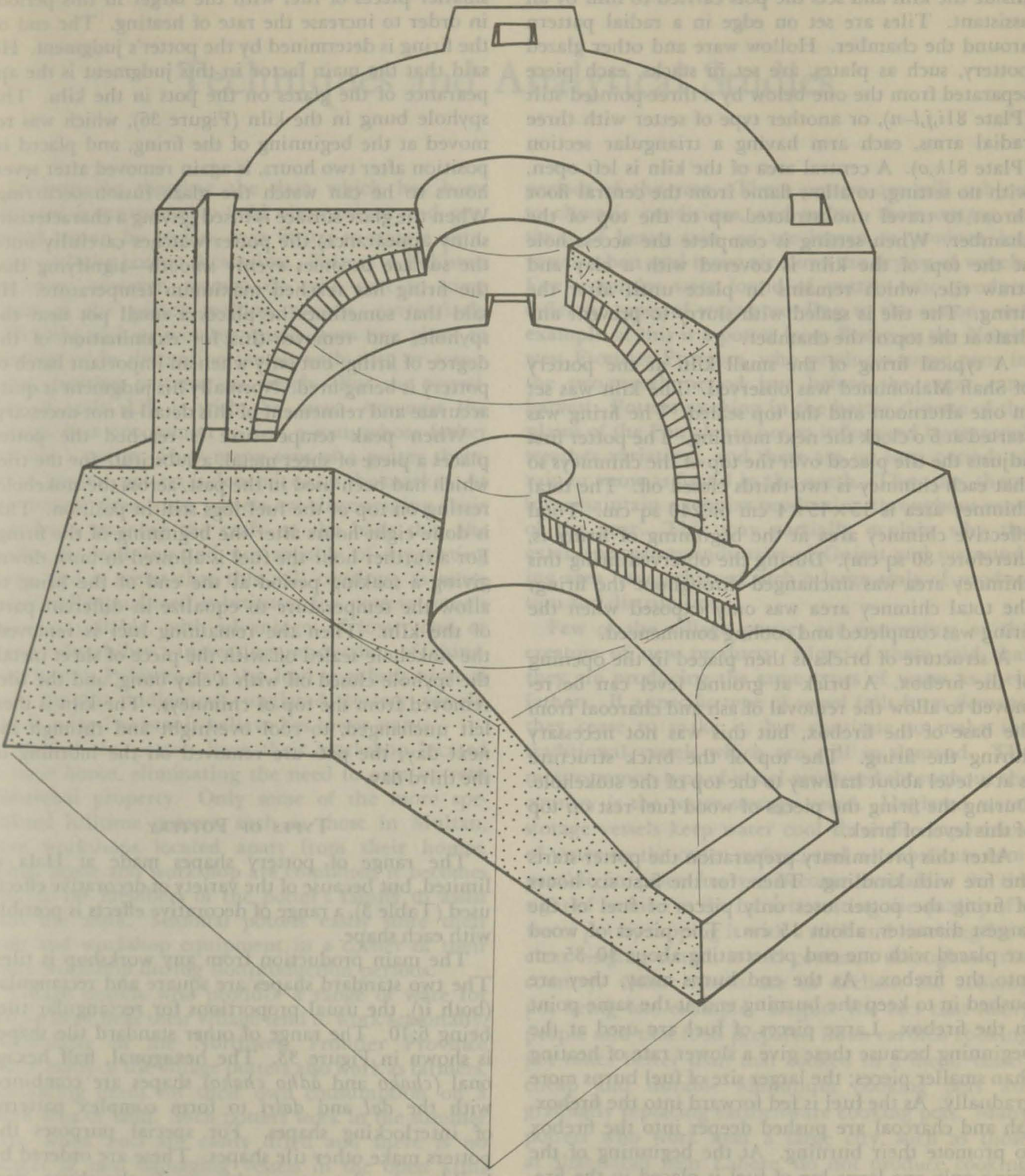


FIGURE 36.—Updraft kiln with part sectioned perspective view, Hala, Sind. (Same kiln as Figure 35.)

inside the kiln and sets the pots carried to him by an assistant. Tiles are set on edge in a radial pattern around the chamber. Hollow ware and other glazed pottery, such as plates, are set in stacks, each piece separated from the one below by a three-pointed stilt (Plate 81*i,j,l–n*), or another type of setter with three radial arms, each arm having a triangular section (Plate 81*k,o*). A central area of the kiln is left open, with no setting, to allow flame from the central floor throat to travel unobstructed up to the top of the chamber. When setting is complete the access hole at the top of the kiln is covered with a clay and straw tile, which remains in place until after the firing. The tile is sealed with slurry to prevent any draft at the top of the chamber.

A typical firing of the small kiln at the pottery of Shafi Mahommed was observed. The kiln was set in one afternoon and the top sealed. The firing was started at 6 o'clock the next morning. The potter first adjusts the tile placed over the top of the chimneys so that each chimney is two-thirds closed off. The total chimney area is 15×15×4 cm or 240 sq cm. Total effective chimney area at the beginning of firing is, therefore, 80 sq cm). During the observed firing this chimney area was unchanged throughout the firing; the total chimney area was only exposed when the firing was completed and cooling commenced.

A structure of bricks is then placed in the opening of the firebox. A brick at ground level can be removed to allow the removal of ash and charcoal from the base of the firebox, but this was not necessary during the firing. The top of the brick structure is at a level about halfway to the top of the stokehole. During the firing the pieces of wood fuel rest on top of this level of brick.

After this preliminary preparation the potter starts the fire with kindling. Then, for the first six hours of firing the potter uses only pieces of fuel of the largest diameter, about 15 cm. The pieces of wood are placed with one end penetrating about 30–35 cm into the firebox. As the end burns away, they are pushed in to keep the burning end at the same point in the firebox. Large pieces of fuel are used at the beginning because these give a slower rate of heating than smaller pieces; the larger size of fuel burns more gradually. As the fuel is fed forward into the firebox, ash and charcoal are pushed deeper into the firebox to promote their burning. At the beginning of the firing only one large log of fuel is placed in the firebox. After three hours this is increased to two, and at four hours from the beginning, three logs. Seven hours from the beginning four logs are placed in the firebox, and one is replaced every 10–15 minutes. The potter said that during the eighth hour the kiln is reaching maximum temperature; he mixes some smaller pieces of fuel with the larger in this period, in order to increase the rate of heating. The end of the firing is determined by the potter's judgment. He said that the main factor in this judgment is the appearance of the glazes on the pots in the kiln. The spyhole bung in the kiln (Figure 36), which was removed at the beginning of the firing, and placed in position after two hours, is again removed after seven hours so he can watch the glaze fusion occurring. When the glaze surface is fused (giving a characteristic shiny appearance) the potter watches carefully until the surface becomes evenly smooth—signifying that the firing has reached maximum temperature. He said that sometimes he places a small pot near the spyhole, and removes this for examination of the degree of firing; but only when an important batch of pottery is being fired. Normally his judgment is quite accurate and refinement of this detail is not necessary.

When peak temperature is reached the potter places a piece of sheet metal, a substitute for the tiles which had been used in the past, across the stokehole, resting on top of the fuel logs still in position. This is done eight hours after the beginning of the firing. For a further hour the fuel is allowed to burn down, giving a soaking period at the end of the firing to allow the temperature to equalize in different parts of the kiln. Then the remaining fuel is removed, the stokehole sealed off with the piece of sheet metal, the spyhole closed off with a clay bung, and the tiles removed from the top of chimneys. The kiln is then left unchanged, to cool overnight and through the next day; the pots are removed on the morning of the third day.

Types of Pottery

The range of pottery shapes made at Hala is limited, but because of the variety of decorative effects used (Table 3), a range of decorative effects is possible with each shape.

The main production from any workshop is tiles. The two standard shapes are square and rectangular (both *iṭ*), the usual proportions for rectangular tiles being 6:10. The range of other standard tile shapes is shown in Figure 33. The hexagonal, half hexagonal (*chạko* and *ādho chako*) shapes are combined with the *dal* and *dalṛī* to form complex patterns of interlocking shapes. For special purposes the potters make other tile shapes. These are ordered by builders or tile setters, who specify the shape, size, and decoration. Conventional tile shapes and decorations are shown in Plate 77.

Utilitarian pottery is mostly lead glazed, particularly for hollow ware. Alkaline glazes are more common on flatware, such as tiles or dishes. Some common examples are shown in Plates 77 and 78.

Techniques and Analytical Studies

In bringing together the data which has been gathered from extensive field observations and presented region by region, it is fitting to start a summary with the potters themselves. Potters in Pakistan are men; however, women do take part in some stages of the pottery-making process, particularly with tasks such as moving vessels from one place to another, or in decorating vessels with slip, or sometimes painting patterns on vessels. But the repository of craft skill is with the men. Amongst the potters, it is uncommon to find a man whose father was not a potter. How many sons of a potter themselves become potters is dependent on the market. At the present time some potters are discouraging their sons from learning the craft on the basis that the market is declining and not capable of supporting them, and it seems that this will continue as more industrially produced substitutes for pottery vessels become available, with advantages of lower cost or greater durability. Increasing production of chinaware within Pakistan can also lead to substitution of ware for the indigenous unglazed pottery vessels, which many Pakistanis believe has lower status.

Most of the potters have their workshop located at their home, eliminating the need to own or rent additional property. Only some of the more specialized fulltime potters, such as those in Multan, have workshops located apart from their homes. When home and workshop are combined it becomes feasible for members of the potter's family to assist with the work. Seasonal potters easily store their tools and workshop equipment in a corner of their home workshop during nonproduction periods.

Village potters who produce a range of ware for people in or near their village tend to work seasonally, particularly in the Northwest Frontier Province where many of the village potters also work as farmers, cultivating grain for their own consumption on a small area of land. Such potters work in the summer only, when pots are easily dried and there is no danger of rain damaging vessels in the open kilns during a firing. More specialized potters, such as the potters in the village of Musazi near Peshawar, who produce a limited range of wares but in large quantities for distribution over a wide area, work for longer periods of the year. These potters are still subject to climatic conditions, and reduce their output in times of heavy rain, or are forced to produce less vessels when cool moist air slows the drying of vessels. Few examples were found of potters who produce different types of ware according to the season; one example of this is a potter from Prang in the Northwest Frontier Province, who produces sugar pans in the two-month period just before the sugar cane harvest. Potters working in the hotter climate of the plains of the Panjab are not so influenced by seasonal weather variations, and there are no long periods of rain or snow as found in the north. They can, therefore, maintain a regular production throughout most of the year. This may partially explain why the extensive pottery industries of Gujrat and surrounding area have achieved such a large scale of production and distribution.

Few of the village potters are innovators or the creators of new products. Most of them said that they are producing the same types of wares as their fathers. If a specific type of vessel falls from demand they cease to make it, but continue to make the traditional vessels which are still in demand. The most common type of vessel produced throughout the country is the water storage vessel. Unglazed water storage vessels keep water cool through evaporation of water on the outer surface, and no substitute comparable in price has yet become available. So the sight of women in the bazaars, testing the quality of a water pot by tapping it with a stick and listening for a clear ringing sound, is still common throughout the country. Other vessels are in decline, the cooking pot being one example. Despite the fact that many people said that food prepared in an earthen cooking pot tastes better than that cooked in a metal vessel, cheap and durable aluminum cooking pots are gradually replacing earthenware cooking pots. Many potters who work near a large city, such as those at Shahdarah near Lahore, do not produce cooking pots at all, but instead produce the types of vessels which are not replaceable by modern industrial products, such as tobacco bowls for hookahs, water jars, and flower pots.

TOOLS AND EQUIPMENT

Potter's Wheel

For most Pakistani potters the primary tool is the potter's wheel. Only in some remote areas of the Northwest Frontier Province is domestic pottery made without the use of a potter's wheel. In the valley of Chitral, some nomadic potters form the base of vessels using a broken base or a pot as a mold; the walls of the vessel are built up using a combination of coiling, and beater and anvil techniques. A potter in the village of Seen in Chitral uses a hand building technique involving a twisted hoop, upon which the base of a vessel is built. The hoop is then removed and the upper section completed. This technique has not been reported from any other locality.

Handbuilding techniques are used in other areas for special products, such as the *tanur*, the large oven used for baking bread, and for cooking pot stands, made by hand-molding from a large slab of clay, and also for industrial vessels such as the sugar pans made in the village of Prang near Peshawar. Both the *tanur* and the cooking pot stand are used all over Pakistan. No parallels were found for the hand-building techniques used in India (Saraswati and Behura, 1966:79–100) with the exception of the "strip building" technique used in Pakistan for *tanur*.

A potter in the Kafiristan valley of Bomboret, near the Chitral valley, uses a turntable (also known as "tournette" or "slow wheel") as a base upon which to form coiled and beaten vessels. Again this was a single case of a specific technique. The possibility arises that this technique may have been used by Kafirs when they occupied a much greater area of the region. This speculation is based on the very slender evidence that the potter using the technique said that he had learned his craft directly from his father, taking the technique back one generation at least. The conversion of Kafirs to Islam, and the primary beginnings of influence of Muslim culture on the Kafirs occurred near the end of the 19th century. Snoy (1969:127–130) referred to use of the turntable by potters in Afghanistan in the village of Kulala in eastern Badakshan, but does not relate its use to a specific ethnic group. He does not indicate that the turntable is used elsewhere in Afghanistan.

The turntable serves only as a stable base upon which vessels are built, and is turned slowly by hand or with the potter's foot, never in complete revolutions but only part of a revolution at a time, to expose another fixed area to the potter for working. By contrast, the type of potter's wheel which may be termed "single wheel" (Saraswati and Behura, 1966: 1–14) is a true potter's wheel where vessels are formed by pressure from the potter's hands with the wheel revolving rapidly. A true potter's wheel such as this revolves at a speed of 100 to 150 rpm while the potter is throwing. Saraswati and Behura indicate that this type of wheel is very common in India, with four subtypes in use. All types are revolved by the potter with a stick inserted in a hole in the top of the wheel, or between spokes in the spoked type, and twirled rapidly.

The single wheel is uncommon in Pakistan. It is used by some potters in Sind, as in Hala and particularly in Karachi. Ghurye (1936:68–71) believed that the "kick-wheel" (pit-wheel) was introduced into Sind from the Panjab around the beginning of the present century; he was given this information by Sindhi potters. He noted that the flywheel of the Sindhi pit-wheels is larger in diameter than that of wheels further north.

In 1971, the single wheel was in use in Gujrat in some workshops, where the potters indicated that it was recently introduced. The wheel in Gujrat would be classified in Saraswati and Behura's system as a "socketed block-wheel," the type most common in the northern and northwestern areas of India. The standardized use of the single wheel in India suggests that the single wheel is traditional to Hindu potters, and that its use may have extended into Pakistan before partition, which provides an explanation for the relative disuse of this type of wheel in Pakistan now. It may be significant that the major limitation of the single wheel is that it restricts the size of vessel which the potter can form on it. A large vessel requires that considerable pressure be applied to the clay by the potter, which quickly reduces the momentum of the potter's wheel, and requires that it be given added momentum by twirling it again with the stick. However, if the vessel being formed is large, the stick cannot be used; its "cone of revolution" limits the size of the vessel (Figure 22). Therefore the single wheel is best suited to the rapid production of small vessels thrown from the hump. According to Dobbs (1895:1).

> In the Smriti Sloka of Yajnavalkya we are told that an earthen pot once touched by food can be purified by being baked again in fire, but if touched by filth it can never be purified. The Matākshara asserts that an earthen vessel must be thrown away if touched by a Chindāla, or man of like caste, while in one of the Shastrās, the special privilege of using earthen vessels for three days without contamination is given to the inhabitants of the holy city Benares. In strong contrast to this dislike of earthen vessels on the part of the Hindus is the practice of the Muhammedans, who are enjoined in the Darrinuktar to use them rather than metal vessels, for the

reason that the Prophet of God has said that those who keep earthen vessels in their houses are visited with respect by angels.

Saraswati and Behura (1966:168) confirmed the continuation of the Hindu practice of discarding defiled vessels, which practice points to the large scale production of small vessels, cheap and easily replaceable.

By contrast, the use of the pit-wheel (Saraswati and Behura's "double wheel") may be traced through countries to the west of Pakistan. Demont and Centlivres (1967:41) document use of a similar type of wheel in Afghanistan. The basic construction of the Afghan potter's wheel is similar to that in Pakistan, but the Afghan wheel is built into a mud wall structure above ground level, by contrast with the Pakistani pit wheel, where basically the mechanical device itself is placed below ground level. Variants of the pit wheel are used by potters in other Islamic countries. Centlivres-Demont (1971:27) documents the use of a wheel similar to the Afghan wheel in Meybod, Iran. Yoshida (1972:111) documents the use of the kick-wheel in Iran, as does Wulff (1966: 154–155). Pit-wheels closely related to those used in Pakistan are used by Arab potters in the Middle East. Examples of this can be seen in Cairo (Rye, 1974), and in the West Bank area and Gaza, both presently in Israeli territory. The traditional Arab potters of Gaza, and of Hebron and Jabaa, in the West Bank, have also been studied by Rye, but this work is not yet published. The Cairo and Palestinian wheels differ from those used in Pakistan and Afghanistan in that the shaft is slightly inclined to the vertical away from the potter as he sits at the wheel; the shaft revolves in a bayonet recess in the top wooden crossmember; but the overall concept and mechanical system of the wheels is identical to those in Pakistan.

This general type of potter's wheel cannot, however, be exclusively assigned as characteristic of Islamic potters; wheels of the same general type are used by Mediterranean potters in Cyprus and Crete (Hampe and Winter, 1962:17), and also in Japan (Sanders, 1967:61). Further research into details of construction of potter's wheels of this type may show to what extent this type of wheel is characteristic of the Islamic potter. A superficial examination indicates that the Japanese kick-wheel may have developed independently of the pit-wheels west of Pakistan.

It has been shown that the single wheel is uncommon in Pakistan, but in almost universal use in India. Conversely the pit-wheel is the most commonly used type in Pakistan; but, according to Saraswati and Behura (1966:15–18), it occurs in India in only a relatively very small area in the northwestern side of India, directly adjacent to Pakistan. This points clearly to distinctly different origins for the potter's wheel of Pakistan, the pit-wheel, and that of India, the single wheel, suggesting that Pakistan's potters, at least in terms of the potter's wheel, have their links with the Islamic countries to the west rather than with India. An introductory discussion of the origins of different types of potter's wheels in antiquity has been provided by Scheufler (1968:2–3). A diagram showing the typical construction of a pit-wheel is shown in Figure 3.

Not enough data has been collected to allow detailed study of the variation in pit-wheels from one area to another in Pakistan but some general observations can be made. In the Northwest Frontier Province typically, the pit in which the wheel is located is excavated directly in the earth and unlined; in the Panjab the pit is excavated and then lined with fired bricks. Potter's wheels in Afghanistan have a wooden beam above the flywheel level at the opposite side of the shaft to the potter's seating position (Demont and Centlivres, 1967:41, fig. 12). This beam acts as a rest for the potter's feet when the wheel is not being kicked. By contrast, pit-wheels in Pakistan have no resting place for the potter's feet. The practice is to rest the left foot on the top crossmember of the wheel directly in front of the potter's body. The right foot continually kicks the flywheel while the potter is throwing or otherwise using the wheel; while the wheel is at rest the potter rests his right foot on the top of the flywheel.

The major pieces of the wheel mechanism are made from wood. Variations in the type of wood used result from the types of wood locally available. In the far northern areas combinations of pine, walnut, and deodar are used (Table 4). From Peshawar southwards the common furniture timbers, *s̲hīs̲ham* (*Dalbergia sissoo*) and *bābul* (also known as *kikkar; Acacia arabica*) are used. The wheels are usually made by furniture makers or wood workers who use the types of wood available to them. In some cases different types of wood are used for different parts of the wheel, harder and more durable woods being used for the parts subjected to the greatest stress (such as shaft, or the wheelhead which is alternately wetted and dried continuously) and less durable, softer woods for the parts receiving less stress, such as the wooden crossmember.

The usual method of fitting the wheelhead to the shaft is to mortise the head and fit this onto a square tenon on the top of the shaft. Commonly, a packing material such as cloth is placed over the shaft tenon and then the wheelhead is driven on with a hammer;

TABLE 4.—*Some trees and plants used by potters in Pakistan (excluding fuels and ash sources)*[1]

ENGLISH NAME	BOTANICAL NAME	VERNACULAR NAMES	USAGE	WHERE USED
Dwarf Palm	Nanhorrops ritchieana	mazrī	Fiber for ropes; leaves for mats, baskets, etc.; temper in tanur making	Dera Ismail Khan Quetta Kharmathu
-	Saccharum munja	munj (also: kana, sar, sarkana, sarkanda)	Leaf sheath fibers for ropes; trays screens, mats; temper in tanur making	Dera Ismail Khan Quetta
Deodar[2]	Cedrus deodara	deodār	Potters' tools; wheelhead and fly wheel of potters' wheels	Bomboret Chitral Swat
Willow	Salix	ghuṛājan (Dir)	Baskets, hoops	Chitral Dir
Walnut	Juglans		Shaft, wheelhead of potters' wheels	Dir Swat
Pine			Crossmember, flywheel of potters' wheels	Dir Swat
Indian Rosewood	Dalbergia sissoo	shīsham	Wheelhead, shaft, flywheel of potters' wheel	Bannu
Acacia	Acacia arabica	kikkar, kikar, bābul	Flywheel of potters' wheel	Dera Ismail Khan

1 References: Parker (1918); Bamber (1916); Watt (1890).

2 In some areas the cypress, Cumpressus torulosa, is also termed "deodār" by local residents.

the packing insures a tight fit. The flywheel is fitted to the shaft by two methods. In one method, the shaft is tapered and has a large diameter at the base; the flywheel has a tapered circular hole that allows it to be driven down and locked on the shaft. A nail driven through the shaft above the flywheel prevents the flywheel from moving upwards on the shaft. Alternatively, the lower section of the shaft may have a tapered square shank, and the flywheel a tapered square tenon; the flywheel is thus completely prevented from revolving on the shaft.

It is significant to note that flywheels made from pine or deodar wood are comparable in diameter on different wheels; flywheels made from heavier woods such as *shīsham* or *bābul* are also comparable in size at different workshops, but the flywheels made from heavier wood types are smaller in diameter than those made from the lighter woods. For *shīsham* or *bābul* flywheels the diameter is about 60 cm; for pine or deodar, about 70 cm. A relatively fixed dimension is the distance from the top of the flywheel to the top of the wheelhead, which varies between 71 and 76 cm. This dimension is determined by the anatomy of the potter, basically the length of his legs, which must reach the top of the flywheel from where he sits. This is the only dimension dependent on the size of a potter. Another variable dimension could be the distance between the shaft and the seat, but on the Pakistani pit-wheel this is varied by the potter himself, who sits closer to or further from the wheelhead. In other words there is not a fixed seat, but the potter can sit at any point along the top crossmember that gives him a comfortable working position. Only in one location was this seating position varied—in the village of Shadiwal, in the Panjab (Plate 38).

Varied estimates of the life of a pit-wheel were given by potters. Some said twenty years, others said "a lifetime," and others said they could not give an estimate because they had always used the same

wheels. The only necessary maintenance is to the bearings. The top bearing of this type of wheel is extremely simple. The circular shaft revolves in a circular hole in the wooden crossmembers. Maintenance consists of lubricating the wood surfaces in contact with a lubricant such as fat, *ghī* (clarified butter) or the oil extracted from apricot-seed kernels. At the wood surfaces in contact, the "bearing" is packed with cotton cloth. The lower bearing in the simplest wheels consists of an iron point, fixed into the base of the shaft, running in a cup of hardwood, stone or iron, fixed into a piece of wood in the bottom of the pit. Occasionally, it is necessary to either sharpen the iron point where a stone or iron cup is used, or to form a new cup where a wooden or soft stone cup is used. The lower bearing is lubricated with the same lubricants as the upper. Many potters replace this simpler type of bearing with a modern ball-race bearing, giving the wheel extra momentum. They said that this bearing requires no maintenance once it has been packed with grease.

Tools Used in Materials Gathering and Preparation

With the exception of a few potters in remote mountainous regions of Northwest Frontier Province, potters use nonindigenous tools, such as shovels, for clay digging. An example of the exception to the rule is the potter of Bomboret, who uses a single-pointed pick-like tool (Plate 2*b*) to dig clay.

The transportation of clay from the deposit to the workshop is normally by donkeys. Potters in the remote northern regions dig clay and carry it in sacks, themselves; for example, Noor Khan of Bomboret carries clay in a leather sack. The maximum load which can be carried in this way is considered to be about 150 lbs, or roughly 70 kg, by people living in these areas. Potters in other areas who dig their own clay often own donkeys. When the clay is dug, the potters place it in donkey bags woven from hair (goat, camel) and cotton or from hemp fiber, for convenient carrying by the donkey. A donkey carries up to 90 kg of clay, depending on the terrain. Specialized potters in some areas buy clay; in this case it is delivered to the workshop by bullock cart (for which the maximum load is about 3000 kg for two bullocks) or in a few cases by truck.

Baskets, woven from materials such as willow twigs or dwarf palm leaves, are used in workshops for general storage or for carrying materials, such as clay or dung fuel, from one place to another.

A wooden stick, commonly a small branch from a tree prepared by having bark and twigs removed, is the common tool used for breaking up lumps of dry clay at the workshop. Fine grinding methods are not used for clay preparation in any of the workshops studied.

Sieves are used in many workshops, for sieving clay or tempering materials or both. In remote northern regions, sieves made from pierced leather (goatskin) stretched over a wooden frame are still in use. This type of sieve, which is also used domestically for sieving grain, is made either by the potters themselves or bought from herdsmen who sell them to villagers.

Where sheet metal, such as zinc-plated mild steel, is available, potters prefer to use it for making coarser sieves. The sheet metal is nailed to a square or rectangular wooden frame, and the holes are punched in the sheet metal. Potters make this type of sieve themselves. This type of sieve has probably not been in use for over the last 20 to 30 years, when such scrap sheet metal has become available. Where fine sieving is required, as in glaze making at Multan, the potters prefer to use modern woven wire sieves as a replacement for the traditional woven cloth sieves. Woven cloth has a very short life under such usage.

Clay is generally prepared on the earthen floor of a potter's workshop. A few potters from the northern regions, who only prepare very small amounts of body, use large wooden dishes, carved from tree trunks, in which to prepare clay. Woven mats, made from materials such as *munj* (*Saccharum munja*) leaf sheath fibers, are used by some potters for kneading clay by foot, the mat being placed on the ground and the clay body on top of the mat. One potter, in Dir, uses a special wooden platform on which to place clay for foot-kneading. Various materials are used to make benches (so called because they are usually placed at ground level) for hand-kneading clay. Slate slabs are used in northern regions where slate is available; in other areas wooden batts are used, or special clay batts made and fired by the potters themselves.

Potters who make glazed ware grind the glazing materials to a fine powder, and this is normally done in two stages: First, coarse lumps of the material are crushed by hammering or, in slightly more refined manner as by the Multan potters, by use of an iron mortar and pestle. A stone quern is then used to reduce the crushed material to a fine powder. The material is fed into the quern through a hole in the center of the top plate; in some cases the bottom plate is surrounded by a trough made from mud and straw, so that ground material issuing from the perimeter of the grindstone surfaces is collected in this trough for easy recovery. In Multan, the quern

is further refined by having provision for raising or lowering the top grindstone slightly, thus allowing control over the particle size distribution of the ground product.

Even finer grinding is required for pigments used by the potters to decorate vessels. These materials are ground by hand using stone mortar and pestle. In the northern regions potters use a river pebble as the pestle and a large flat stone with a concavity in the top surface for grinding. Potters in other areas use basalt mortars and pestles, which are available commercially.

Tools and Equipment Used in Forming Processes

Apart from the potter's wheel, Pakistani potters use a variety of tools in forming processes. Water is used by potters throughout the different stages of forming, no matter what the process, so one of the most common pieces of equipment is a water container. Most potters choose to use a vessel which they have made themselves, either a bowl made especially for the purpose or a vessel which has been damaged in firing but can still be used to contain water. Potters who use the pit-wheel for throwing, normally have a bowl permanently set into the ground beside the wheel, and about a gallon of water is normally kept in the bowl. Other potters who work in different areas of their workshop have a portable vessel so that water is available wherever they are working.

Plain dish molds, as used by Northwest Frontier Province potters for forming the initial stage of vessels on the wheel later to be completed by paddle and anvil, are made by the potters themselves and fired before use. One potter noted that these molds improve with age, because the pores of the earthenware molds fill with clay and there is less tendency for clay to stick to the mold.

In order to place these molds on the wheelhead, the potter first places an annular hoop of twisted cloth directly on the wheelhead and then places the mold on this. The hoop is made from scraps of cotton cloth, either by the potter or by women in his family. These hoops are only used in the Northwest Frontier Province, as are the plain dish molds used for forming the base of vessels.

A more sophisticated refinement of the simple base mold is the two part mold used for forming the body section of water pots and some other vessels. The two parts of the mold, consisting of the lower (undecorated on the interior) and the upper (usually decorated on the interior with incised patterns which become relief decorations on the molded vessel) portions, are either made by the potters themselves, or, in the case where sufficient potters in a village are using this forming technique, by specialist mold makers. The molds are made from the ordinary clay body used by the potter for other vessels and fired. These molds are used over a wide area of Pakistan; it appears that the patterns carved into the upper mold are characteristic of specific areas, but unfortunately there is not enough data to expand that observation. Molded vessels, formed by similar methods to those which were observed in Musazi (page 30) were seen by Rye in Sind, Panjab, and the Northwest Frontier Province; they are also made in Quetta (Plate 53).

Some potters, such as those in the village of Shadiwal, Panjab, making large dishes, use profile tools to shape vessels while throwing. These profiles are simply rim sherds from broken vessels, salvaged rather than specially made for the purpose. They are used to give a smooth curvature on the upper side of the dishes.

Commonly, potters complete the rim form of thrown vessels by smoothing the rim with a wet cloth, a small piece held between their fingers. This cloth is waste material made from worn-out clothing.

Vessels that are thrown from a lump of clay placed directly on the wheelhead, as opposed to being thrown in a mold, are cut through under the base before they are lifted off. The common tool for cutting off is a piece of thread, usually cotton, often two or four strands twisted together. Held in both hands, this thread is pulled through underneath the revolving vessel. An alternative method of cutting off is to make a shallow groove around the vessel base where it is to be cut off, and then with the wheel revolving slowly, to touch one end of the thread to the soft clay, allowing the revolution of the wheel to carry the string around the groove. When the string completely circles the pot the other end is pulled to cut through and free the vessel.

As already mentioned, base molds as used in the Northwest Frontier Province are round-bottomed, and therefore require a cloth hoop for firm placement on the wheelhead. Another method for removing a soft vessel from the wheelhead without distortion was seen in Multan where the potters use tiles as a base on which to throw vessels. The tile is fixed to the wheelhead with pieces of plastic clay, a flat shape, such as a dish or bowl, is thrown, and then the tile and vessel are removed together by lifting off the tile. Tiles for this purpose are simply the type of tile in ordinary production, fired but unglazed.

Measuring tools are not commonly used; materials

are proportioned volumetrically during preparation by any suitable container and only exceptionally by weight by a simple beam scale.

Perhaps the only piece of equipment which can be categorized as a measuring tool used for forming is the template as used by tile makers at Hala, or the measuring stick used by Multan tile makers and some other specialized workers, such as *tanur* makers. The potters construct these devices to allow for the drying and firing shrinkage of the clay body.

Northwest Frontier Province potters who use base molds to form vessels form the upper walls of the vessels by throwing and afterwards complete the shape with beater and anvil. Wooden smoothing tools (Plate 79) are used to refine and smooth the thrown upper walls of the vessels, by holding the wooden tool against the wall as the vessel revolves on the wheel.

The beater and anvil technique of completing the base of round-bottomed vessels is used throughout Pakistan. Beaters are made from wood. There were basically only two types, those with a flat or slightly convex surface, and those with a concave depression on the working face. Beaters with patterned faces, such as are commonly seen in India (Saraswati and Behura, 1966:22–23), were not seen in Pakistan. Some beater types are shown in Plate 79. Generally, potters have a range of both beaters and anvils; the weight and curvature of the working face varies according to the size and curvature of walls of the vessels for which they are used.

In the remote northern regions, anvils are river pebbles selected carefully from river beds, on the basis of weight, size, and curvature of the stone. A circular stone, flattened in profile, is the preferred shape (Plate 80).

Potters in Pakistan, with the only exception just mentioned, use fired anvils which they make themselves from the normal pottery body clay. Typical anvils are shown in Plate 80. As with the beaters, potters normally have a range of anvils with varying curvature on the contact face for use in forming a range of vessels of various sizes.

The common beating technique is for the potter to sit with his back resting comfortably against a wall and with his legs extended and a rest under his knees. Usually the rest is a rolled mat or sack. The vessel to be formed is then placed on a mat resting over his knees; this mat is either made from sturdy cloth or from woven vegetable fibers. Neither the knee-rest nor the mat are exclusively made for potters, but are simply common objects of use among the villagers.

By contrast, the potters of Dera Ismail Khan use a series of special base molds for beating out the base of vessels, such as water pots, in a series of stages; they also use a special form of anvil which has a long wooden handle for beating the base of the vessel into the mold. This technique was not seen in any other area of Pakistan included in this study. The special equipment used at Dera Ismail Khan is made by the potters themselves; the base molds are fired clay, as are the anvil heads.

Glazed ware potters do not use the beater and anvil technique, but refine thrown forms by turning. Turning is not exclusively limited to glazed ware potters; for example, potters at Bannu form unglazed vessels by throwing and turning. However, turning tools are of standard form wherever the technique is used; potters make the tools themselves. A strip of sheet metal is bent at one end (Plate 58) to form a cutting edge, the other, longer end of the strip functions as a handle for the tool. These tools are not sharpened, but in use retain a sharp cutting edge because they are held at an acute angle to the abrasive-containing (e.g., quartz grit) wall of the vessel. When the tool becomes worn down it is replaced by another.

Various forms of chuck were seen in use, the function of these being to hold a leather-hard vessel in place on the wheelhead while the vessel is being turned or otherwise modified (for example, in applying perforated decorations; Plate 57). The simplest type of chuck is that made from plastic clay, formed to an appropriate shape on the wheelhead, and then removed after use, when it is dried and the clay recycled. More sophisticated chucks, made from fired clay by the potters, are used when production is in sufficient quantity to warrant their use; an example being the type used at Shahbaz Ahmed Khel, near Bannu (Figure 10).

Tools Used for Decoration

Vessels from many centers are decorated with forms of incised patterns, but special tools for applying this decoration are uncommon. A pointed, small, wooden stick is generally used for incising bands or wavy lines. More common is the application of a coil of plastic clay around a vessel, followed by the impression of rhythmic patterns with the fingers, or direct decoration in the plastic clay itself by the fingers; in either case no tool is used.

The more common forms of decoration are coating with slip, which is applied either by wiping on with a cloth (particularly in the Northwest Frontier Province), which is invariably a piece of waste cloth such as worn-out clothing, or by pouring slip over the vessel. Any convenient container is used for pouring. Pigment decoration is applied with brushes,

about which the potters are much more careful. They make their own brushes; donkey mane is the most common material for brushes used for broader decorations on unglazed ware. Glazed ware potters who decorate with finer patterns prefer finer hair, such as camel or squirrel. Brush handles are made from the stem of large feathers, for fine brushes, but brushes made from donkey mane do not have handles. The hairs are cut long (up to 7–8 cm) and then about 5 cm of the bundle of hair is bound with thread to form the handle of the brush.

Equipment Used in Firing

For firing, unglazed ware can be stacked one vessel upon another. Glazed ware, however, has to be set in kilns in such a way that vessels do not come in contact, otherwise glazed surfaces will fuse together. Potters use props and stilts (Plate 81) for setting glazed ware. These are invariably made by the potters themselves, from the same body used for forming their normal range of wares. If not damaged when breaking them away from the vessels after firing, the stilts are reused a number of times; the props are used until they are damaged, usually after several firings.

Materials Used for Tools and Equipment

In considering the potter's materials most discussions center around clays and other body materials, fuel, and kiln-building materials. It should not be forgotten that the potter uses a wide range of materials, particularly for making tools and minor or even "expendable" equipment.

Other equipment used by the potter reflects common usage in his area. Some examples which have been noted are leather sacks, woven fiber mats, baskets, sieves, and cloth. Such equipment is identical to that used by villagers for other purposes. The potters only develop special tools or equipment when their craft requires something not readily available in the general community.

A summary of the major trees and plants providing materials used in the potter's workshop is given in Table 4. This may be compared with Table 5 where plants used by potters as fuels are given.

It is necessary to discuss some aspects of the use of materials which are not included under other headings. Demont and Centlivres (1967:57) have well summarized the economics of material use by potters in Afghanistan, and their comments apply equally to the village potters of Pakistan (translation from the French by the authors):

> In a subsistence level economy of the kind prevalent in most of Afghanistan even a minimal expenditure represents a hardship. All material objects are consequently used to their fullest extent. Even waste materials are put to some kind of use. Pieces damaged during firing are sold "as is" if not too badly deformed, or repaired with a sort of cement. The potter

TABLE 5.—*Fuel plants used by potters in Pakistan*

English name	Botanical name	Vernacular names	Usage	Where used
Indian Rosewood	Dalbergia sissoo	shīsham	Fuel, updraft kiln	Gujrat Zakhel Bala
Blue Pine	Pinus excelsa	sunti (Dir) sonṭay (Dir)	Domestic fuel; lighting; bark as potter's fuel in pit firing.	Dir Bomboret
Pine			Bonfire firing fuel; domestic fuel	Chitral
Pine	Pinus longifolia	cīr	Fuel	Gujrat
Artemesia	Artemsia	drōṇ (?)	Bonfire firing fuel; domestic fuel	Chitral
Mustard	Brassica campestris	sarso kā bhōh	Straw as fuel; seeds for oil	Kharmathu
-	Stereospermum suavoleas	partal	Fuel	Gujrat
Poplar	Populus euphratica	bhān ubhān	Fuel, updraft kiln	Multan Hala
Acacia	Acacia arabica	kīkar kikkar	Fuel, updraft kiln	Multan Hala
Jujube	Zizyphus jujuba	bābul ber	Fuel, updraft kiln	Multan
Jand	Prosopis spicigera	janḍ	Fuel, updraft kiln	Multan

himself uses broken pieces to close the mouth of the kiln. In some cases he crushes sherds to add to the clay as temper. In his workshop, damaged pieces or the bottoms of jars serve as receptacles for slip and other materials. Waste clay removed during vessel manufacture is put in the bottom of a broken bowl or base of a jug, which then is used as a mold. Other fragments are used as scrapers or polishers. In general, all artisans have fragments of jars or jugs in their workshops for storing the water they use in their work. In jewellers' workshops, the base of the small hemispherical earthen furnace for smelting precious metals is a large fragment of a jug bottom. During the rainy season, the garden paths are covered with sherds reduced to the size of gravel. Gardeners employ jars with broken necks as watering cans. Fragments of pottery are even used for intimate purposes. These are only a few examples.

The potters' recovery and use of "discard" material is equally evident in potters' workshops in Pakistan. In addition to the observations quoted above, it is worth commenting that many materials, but not all, used in the potter's workshop are characteristic of his craft. The potter's wheel is, as has been briefly noted above, always made from wood, which is used in the potter's village area for furniture or in other common woodworking applications. Thus wood such as deodar, walnut, the acacia (*bābul*) and the very common Pakistani furniture wood *shīsham* (*Dalbergia sissoo*) are all used in potters' wheels. The particular wood types used in a specific area of the country are those which are most readily (and economically) available to the furniture maker.

MATERIALS

Clays

In terms of weight, clay and fuel are the two major materials used by the potter, so it is necessary to summarize data relating to the problem of supply and transport of clay. The mineralogy of Pakistani potters' clays has been studied both in order to understand the characteristics of the clays, and to determine whether or not the mineralogical characteristics of the clays are related to other aspects of the potter's craft. The mineralogical studies are reported first, and then the findings from those studies are summarized. Discussion of more general aspects of clay use by Pakistani potters follows, including discussion of supply and transport.

X-ray Diffraction Study of Clays

During field studies, samples of clay used for making pottery were collected. These samples were subsequently accessioned into collections of the Smithsonian Institution, and are referred to in the following discussion by both the location from which the original samples were collected, and by USNM catalog number.

Fourteen samples of clay used for pottery bodies and two samples of clay used in slips were selected for study by x-ray diffraction. All of these samples were originally collected from the potters by whom they were used. The samples were obtained from stockpiles of the raw material kept at the potter's workshops, and are representative not of the entire deposit of clay from which the potter customarily obtains clay, but only of the clay in use at his workshop at that particular time. In order to obtain some estimate of variation in the clay used in a pottery workshop over a period of time, two "time-matched" samples are included in the study. From Zakhel Bala (NWFP) a sample which was collected in 1968 is included along with a sample collected in 1971; and from Hala (Sind), a sample which was collected in 1967 is included along with a sample collected in 1971.

Of clays used for making unglazed ware, samples from the following locations are included: Bomboret, Seen (Chitral), Aḥam Ganj (Swat), Kharmathu (near Kohat), Shahbaz Ahmed Khel (near Bannu), Dera Ismail Khan, Gujrat (workshop of Sardar Mahommed, Garhi Maqbulabad, Panjab), and Ahmedpur East, Panjab (Bahawalpur pottery).

Of clays used for making glazed ware, the following samples are included: Zakhel Bala, 1968 sample; Zakhel Bala, 1971 sample; Pabbi (near Zakhel Bala and Peshawar); Multan; and Hala, 1967 sample and also 1971 sample.

Two clays used for slip were also studied, and the results are included here for comparison with the body clays. These samples are a yellow clay sold in Gujrat and used over a wide area of the Panjab as a red slip for unglazed ware; and a 'mudstone' used by potters in Quetta as a brown slip applied to vessels before glazing.

Method.—The mineralogy of the clay samples was studied by x-ray diffraction. The original field samples, weighing between 1–10 kg, were subdivided by quartering to give subsamples of about 10 g each. These samples were then ground wet using distilled water in a porcelain mortar for ten minutes and

slides of oriented aggregates prepared by placing drops of the suspended clays on glass slides and allowing the water to evaporate. It will be noted that this preparation retained the mineral assemblage of the clays as used by the potters, and did not involve separation of the clay mineral fraction ($>2\ \mu$).

The oriented aggregates were analyzed on a Philips x-ray diffractometer, using CuK alpha Ni-filtered radiation at 35 kv, 15 ma. A complete scan was made for each sample (from 4° 2Θ through 36° 2Θ) at a scanning speed of 2° 2Θ per minute (corresponding to 2° per inch on the chart). Each sample was then scanned under "slow scan" conditions (one quarter degree Θ per minute) from 24° 2Θ through 26° 2Θ in order to differentiate chlorite and kaolinite by the criteria outlined by Biscaye (1964). The slides were then exposed to a saturated atmosphere of ethylene glycol, after which a further scan was run from 2° 2Θ through 12° 2Θ to specifically identify montmorillonite/chlorites and vermiculite.

Essentially, this procedure provided diffractograms enabling qualitative evaluation of the mineral assemblage present in the clay samples. In order to obtain slightly more precise data enabling comparison of samples one to the other, peak height intensity ratios were calculated within two groups of minerals. These groups were kaolinite/chlorite/illite, and quartz/calcite/plagioclase.

Within the first group the ratio kaolinite/chlorite was determined from peak heights of the 3.58 Å (kaolinite) and 3.54 Å (chlorite) peaks. The positive identification of chlorite/kaolinite allowed by the slow scan diffractograms enabled identification of peaks on the "fast" scan diffractogram in the 7.08 Å to 7.16 Å region, so that peak heights in this region could then be compared with the illite peak at 10 Å. Peak height ratios were then calculated on the basis kaolinite=1 for each sample because all of the samples contained kaolinite; these ratios are given in Table 7. It should be pointed out that these are not relative amounts of the different clays but ratios of peak heights from the diffractograms.

Within the second group, quartz/calcite/plagioclase, peak height ratios were determined from the "fast" scan diffractograms using peak heights from the 4.3 Å (quartz), 3 Å (calcite) and 3.2 Å (plagioclase) peaks. Because quartz was present in all samples peak height ratios were calculated on the basis quartz=1. The results are shown in Table 7.

Because of the limitations in present methods of obtaining quantitative data from diffractograms (Pierce and Seigel 1969), no attempt has been made to arrive at precise methods of reporting, such as by percentage of individual minerals present in samples. A semiquantitative estimate of the relative amounts of minerals present in a sample was arrived at by the following method. From the diffractograms, peaks with low intensity have been taken to indicate the presence of relatively small amounts of the mineral producing that peak. For example, low intensity peaks in the 28.4–5° region, corresponding to potash felspar, occurred in many of the diffractograms. Such low intensity peaks have been reported in Table 6 by the symbol "m," which indicates a "minor" constituent of that mineral. By contrast, peaks of relatively high intensity, considering the group of samples as a whole, have been reported in the same table by the symbol "M," indicating that the specific mineral referred to was a major constituent of the sample. Because this method was somewhat subjective, cases arose where it was difficult to decide into which category the mineral should be placed; this difficulty was overcome by use of a third symbol, "M/m," which indicates that within a sample the mineral was present "in significant quantity."

Results of Technical Studies.—Reference to Tables 6 and 7 shows that all samples contained kaolinite, illite, and quartz. The clay from Multan was the only one not containing chlorite. The Kharmathu and the Shahbaz Ahmed clays and one sample from Hala, contained no montmorillonite and the 1971 Hala sample showed only a minor montmorillonite content.

The chlorite/kaolinite ratio was relatively constant within the limits of the method of calculation, for all body clay samples except two. These were the clays from Bomboret, which had a chlorite/kaolinite ratio of 8 to 1 as compared to the 0.2–2.4 to 1 range for other samples; and the Multan clay which contained no chlorite.

Reference to the kaolinite/chlorite/illite ratios for the two time-matched samples from Hala, and also those from Zakhel Bala, shows that these ratios varied considerably from the earlier sample to the latter in both cases, probably indicating varying composition of the clay deposits used in both areas. This variation was also evident in the quartz/calcite/plagioclase ratios. Both the Zakhel Bala and Hala paired samples were consistent from the earlier to the later samples in the overall mineral assemblage, despite variations in the relative amounts of minerals present.

Some of the clays showed quite distinctive characteristics. For example the Alam Ganj (Swat) clay contained amphibole, not present in any of the other clays. The Bomboret, Seen (Chitral) and Alam Ganj (Swat) clays did not contain calcite, by contrast with

TABLE 6.—*Mineralogy of Pakistan body clays and slip clays by location and catalog number*

MINERALS	Bomboret (Kafiristan) USNM 417,522	Seen (Chitral) USNM 417,421	Alam Ganj (Swat) USNM 417,323	Kharmathu (NWFP) USNM 417,540	Shahbaz Ahmed Khel (NWFP) USNM 417,269	Dera Ismail Khan (NWFP) USNM 417,233	Garhi Maqbulabad (Gujrat) USNM 417,248	Ahmedpur East (Panjab) (Field No. 71-441)	Zakhel Bala (NWFP) USNM 412,456	Zakhel Bala (NWFP) USNM 417,315	Pabbi (NWFP) USNM 417,311	Multan (Panjab) USNM 417,205	Hala (Sind) USNM 410,493	Hala (Sind) USNM 417,127	Clay for red slip, Garhi Maqbulabad (Gujrat) USNM 417,250	Clay for brown slip, Quetta (Baluchistan) USNM 414,553
Kaolinite	m	M	M/m	M/m	M/m	M/m	M	M/m	M	M	M/m	M	M	M/m	M	M
Chlorite	M	M	M/m	M/m	M	M	M	M	M	M/m	M/m	-	m	M	-	-
Illite	M	M	M	m	m	M/m	M	M	M	M	m	M	m	M	m	M
Montmorillionite ..	M	M	M	-	-	M	M	M	M	M	M	m	-	m	-	-
Quartz	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Calcite	-	-	-	M	M	M	m	M	M/m	M	M	m	m	M/m	m	-
Plagioclase	M	m	M	m	m	m	m	m	M/m	M/m	m	m	m	M/m	-	-
Potash felspar	m	m	m	-	-	-	m	m	m	m	m	m	-	-	m	-
Dolomite	-	m	-	-	-	-	m	-	m	m	-	-	-	-	-	-
Amphibole	-	-	M	-	-	-	-	-	-	-	-	-	-	-	-	-

M = present as a major constituent; m = present as a minor constituent; M/m = present in intermediate quantity, significant amounts; - = not present.

TABLE 7.—*Peak height ratio of kaolinite: chlorite: illite (on basis of kaolinite=1.0) and quartz:calcite:plagioclase (on basis of quartz=1.0), calculated from X-ray diffractograms of Pakistan body clays and given by location and catalog number*

MINERAL	Bomboret (Kafiristan) USNM 417,522	Seen (Chitral) USNM 417,421	Alam Ganj (Swat) USNM 417,323	Kharmathu (NWFP) USNM 417,540	Shahbaz Ahmed Khel (NWFP) USNM 417,269	Dera Ismail Khan (NWFP) USNM 417,233	Garhi Maqbulabad (Gujrat) USNM 417,248	Ahmedpur East (Panjab) Field No. 71-441	Zakhel Bala (NWFP) USNM 412,456	Zakhel Bala (NWFP) USNM 417,315	Pabbi (NWFP) USNM 417,311	Multan (Panjab) USNM 417,205	Hala (Sind) USNM 410,493	Hala (Sind) USNM 417,127
Kaolinite	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chlorite	8.0	2.0	1.5	2.0	2.4	2.0	1.6	2.0	2.0	0.5	1.0	-	0.2	2.0
Illite	5.0	2.0	1.2	0.5	0.8	0.7	2.4	2.0	3.0	1.5	0.5	0.8	0.4	3.0
Quartz	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Calcite	-	-	-	2.1	1.5	1.7	0.3	0.6	0.6	1.0	1.3	0.9	0.1	0.9
Plagioclase	1.8	0.5	0.6	0.3	0.3	0.4	0.4	0.5	0.6	0.5	0.3	0.7	0.1	1.2

- = not present

all the other body clays where calcite was present, often as a major constituent.

Comparison of glycolated and unglycolated diffractograms for the Alam Ganj clay showed a high montmorillonite content relative to all the other clays. The diffractograms for the Bomboret clay showed a much higher intensity peak for plagioclase than that of any of the other clays.

The two samples of clays used as slips were distinctive in that peaks corresponding to chlorite and illite were not found on the diffractograms; both of these clays apparently consisted primarily of kaolinite and quartz with significant illite content.

The body clays from the three northern mountain regions of Alam Ganj (Swat), Seen (Chitral), and Bomboret contained no calcite, whereas calcite was present in all the other body clays and as a major constituent in clays from the three areas west of the Indus (Kharmathu, Shahbaz Ahmad Khel, and Dera Ismail Khan) and those from Ahmedpur East, Zakhel Bala, and Pabbi.

The general distinction between the three mountain clays and the others included in this study may be understood by reference to the geology of their areas of origin. The Bomboret and Seen clays both were obtained from weathered slates in situ, in a similar geologic zone (*Geological Map of Pakistan,* 1:2,000,000 scale, 1964 edition, Government of Pakistan) comprising Paleozoic metamorphics and volcanics.

The Alam Ganj clay was dug from an alluvial deposit on the banks of the Swat River, near Alam Ganj village; source for this alluvial deposit is both igneous and metamorphic with the granites, gneisses, and schists of possible Precambrian age and with intrusions of diorite, granodiorite, granites, and syenites of probably Tertiary age.

By contrast, all the other body clays included in this study are from sedimentary or complex alluvial provenience. The region surrounding Peshawar, including Pabbi and Zakhel Bala, consists of Quaternary or Recent alluvium, with unconsolidated surficial deposits of silt, sand, and gravel. All the other body clays were derived from sources within the Indus River subdivision. The region surrounding Gujrat contains piedmont deposits; Kharmathu (Kohat) Miocene, Eocene, and Paleocene shales, sandstones and limestones, and Jurassic interbedded shales and limestones. Shahbaz Ahmed Khel (near Bannu) and Dera Ismail Khan are both within the same area of early Recent piedmont deposits, with limestones and other sediments in the source areas. Lower on the Indus Plain, Ahmedpur East is in a complex region of Pleistocene loess and flood plain deposits, and early Recent streambed, meander belt and sand deposits. Multan (Panjab) and Hala (near Hyderabad) are both in regions of meander belt deposits and flood plain deposits of the lower Indus terrace.

The samples may therefore be divided into two major groups according to the geologic source of the clays: the Seen, Bomboret, and Alam Ganj clays from metamorphic or volcanic and igneous regions; and the other body clays from unconsolidated alluvial, or sedimentary sources. The calcite content of all clays in the latter group may be in part related to large limestone deposits in the alluvial source areas. One sample from Hala contained calcite derived from snail shells; the calcite in all other samples was finely disseminated throughout the clay.

All the analyzed clay samples contained kaolinite, illite, and quartz. Most had a complex assemblage of minerals including the clay minerals montmorillonite and chlorite. These clay samples from the mountainous northern regions were distinct from all the other samples, particularly in the absence of calcite, which was present in all other clays. Two mountain clays from Bomboret and Seen were obtained from primary sources of weathered slates; all other clays were of complex alluvial or secondary origin.

General Summary

One of the more interesting findings made in the mineralogical studies is that, at the qualitative levels of precisions of this study, there were no essential distinctions between clays used for glazed ware and for unglazed ware. This indicates that potters in Pakistan do not choose their clay because of some specific mineralogical advantage it possesses. Of course, all clays used by potters had appropriate working and firing characteristics, but the mineralogical study indicates that the concept of a "suitable clay" is broad.

In answer to the question, "Why do you use this particular clay in preference to others which are available?" the usual answers by potters indicate that they use the closest deposit of suitable clay which can be obtained free of charge. Many of the potters said that there are several deposits of clay near the village or town which would produce good-quality pottery. Ultimately the choice became one of cost and ease of access and transport. Clay is always obtained from open pits on uncultivated land or sometimes from the village common. Mining by shaft or tunnel was not seen.

There is no evidence to suggest that the location of a potter's workshop is chosen so that clay is available at the workshop site. This could not be tested fully because the potters who were interviewed were nor-

mally at least the third or fourth generation to continuously use the same workshop. Two potters who had learned their craft elsewhere and then moved to the village where they were interviewed were Noor Khan of Bomboret valley and Khan Zada of Dir. Both of these men had first chosen the site of their workshop and afterwards located the nearest suitable clay deposit where the clay could be obtained free.

In summary, the evidence is that workshop location determines clay deposit location rather than the reverse. This is supported by clay mineralogy studies which show that a variety of clay types are suitable for making particular unglazed ware; if necessary the working and firing characteristics of clays can be modified by the addition of a nonplastic or organic "temper." Thus the concept of a suitable clay to the Pakistani potter is mineralogically broad.

There is no evidence to suggest that specific "types" of clay are chosen for making specific categories of ware. For example, potters who make both cooking vessels requiring good thermal shock characteristics, and water storage vessels, requiring appropriate porosity, do not vary the clay to produce different properties in the fired vessel. Where variations in the body are made the nonplastic, or temper, component of the body is changed.

For example, the potter Amir of Swat, used coarse sand temper for cooking vessels and fine sand for vessels intended to contain liquids. Potters making glazed ware also use the same clay for different types of ware, for example, the potters of Multan and Hala, use the same body for tiles and vessels. The Zakhel Bala potters used the same body for glazed and unglazed ware.

Only one potter of all those interviewed, Khan Zada of Dir, uses two distinct clays. These are mixed for the body of unglazed ware. One clay is refractory, but has poor workability, the other plastic but with poor firing properties. All other potters use one clay only.

Reliable data on the amount of clay used by potters is not available, primarily because the potters evaluate clay use in "donkey loads" rather than units of weight. Northern village potters making unglazed ware tend to vary production during their three to four month working season so their estimates are less reliable than those given by potters having consistent production.

Observations by the Potters about Clay

Glazed Ware Potters.—Roshan and Hassan Din, Zakhel Bala, use up to 250 kg per day; about 3600 kg per month at full production; work all year round. Hala tile makers, 4500 kg per month; workshop with several assistants; work all year.

Unglazed Ware Potters Working Alone.—Abdul Janab, Musazi, making large vessels, 1500 kg per month average, working all year. Amir, Swat (range of household vessels), 1500 to 1800 kg per month, working three months per year only. Khan Zada, Dir (range of household vessels) up to 1300 kg per month, three to four months per year; wheel forming, beater and anvil. Mehrab Shah, Seen, Chitral (household vessels), about 120 kg per month for three to four months per year; coil forming, beater and anvil. Noor Khan, Bomboret (household vessels), about 25 kg per month, variable, three to four months per year; turntable, coiling and beater and anvil.

Most clay deposits are less than 5 km from the potter's workshop, and in a very few cases the clay deposit is less than 100–200 m from the workshop. Only one potter uses a very distant clay source, Mehrab Shah of Seen village in the Chitral valley. He has to make a full day's journey for clay gathering, going out early in the morning, digging the clay and transporting it back late at night.

Clay is transported on donkeys, and potters usually own one or two donkeys, particularly those who have to travel 3 to 5 km from workshop to deposit. A donkey can carry about 2 maunds, or 90–100 kg, of clay in two bags, one on each side.

If the potter works alone he digs his own clay. Potters who share a workshop (normally brothers) divide the work, one going out to dig clay while others continue the workshop routine. Occasionally, the task of digging and transporting clay is entrusted to responsible sons of potters when they were old enough to do this work.

Of the potters making glazed ware, only those from Zakhel Bala are digging their own clay. The Quetta, Multan, and Hala potters buy their clay from contractors who dig the clay and deliver it to the workshop, although potters in the latter two areas said they can dig their own clay free of charge if they wish. It is more economical for them to pay for clay and spend the time in production. The higher degree of craft organization among the glazed ware potters is reflected in this distinction of clay acquisition; the potters making unglazed ware, never buy their clay, they always dig their own.

Tempering Materials

In the discussion of clays used by Pakistani potters, it has been noted that clays are chosen on the basis

of relative workability, and firing properties are adjusted by the addition of tempering materials.

Potters making vessels or tiles, glazed or unglazed, do not add organic temper to the body anywhere in Pakistan where studies were made except for a few minor variations. The potters of Zakhel Bala, when making unglazed ware, sprinkle dung ash on a stone slab used as a platform for hand-kneading. Although some ash is incorporated in the body by this process, the primary aim of this procedure is to prevent the clay from sticking to the stone slab. Multan potters mix cotton waste with clay to be used for joining thrown sections of vessels and to reduce shrinkage of the clay, but the cotton is not a component of the normal body used for vessels or tiles.

The only significant use of organic temper is by *tanur* makers, who use chopped vegetable fibers, plant ash, and other additives for the body of these bread ovens.

Some potters add salt (common salt, NaCl), to bodies used for unglazed ware. This practice was seen only in a limited area west of the Indus, in Kharmathu village, near Kohat (p. 39). A Multan potter also referred to the addition of salt to the body for unglazed water vessels, but the process was not observed, so no further comment can be made. The potters from Kharmathu said that storage vessels made from a body with salt added keep the water cooler.

By far the most common temper, or nonplastic, is sand. To compare the sands used by different potters, a mineralogical and particle size distribution study of samples collected in Pakistan has been completed.

Analytical Study of Nonplastics

Eight samples of sands used as tempering materials were analyzed. These eight samples were obtained from the same sources as the clays that have been studied by x-ray diffraction, and were chosen for analysis because they were used by the potters to compound bodies based on these clays. The sand samples were obtained from stockpiles of material at the workshops of various potters. Samples from workshops where unglazed pottery is made were obtained from: Alam Ganj (Swat), two samples, coarse sand and fine sand; Kharmathu (near Kohat); Shahbaz Ahmed Khel (near Bannu); Garhi Maqbulabad (Gujrat), from the workshop of Sardar Mahommed. From workshops producing glazed ware, samples were obtained from Zakhel Bala, Pabbi, and Multan. Catalog number of these samples are in Table 8.

All samples were prepared by the potters, ready for addition to the body, either by mixing with the clay before adding water, or for addition during kneading, depending on the technique used at the particular workshop. That is to say, if the practice at a particular workshop was to sieve the sand before use, then the potter was asked to sieve the sample in the normal way. If any other preparation procedure was normally used, such as separating organic material, the potter was asked to do this. Consequently the analyzed samples are as representative as possible of material actually used by the potters.

METHOD.—The eight sand samples were analyzed for mineral content and particle size distribution (Table 8). Because none of the workshops used

TABLE 8.—*Mineralogy and particle size distribution of Pakistan body sands*

SAMPLE LOCATION AND USNM NUMBER	MINERALS (percent)						PARTICLE SIZE DISTRIBUTION (Cumulative percent passing sieve)								
	Heavy minerals	Rock fragments	Carbonates	Micas	Felspar	Quartz	USS 18, 1.00 mm	USS 40, 420 μm	USS 70, 210 μm	USS 80, 177 μm	USS 100, 149 μm	USS 140, 105 μm	USS 200, 74 μm	USS 230, 63 μm	Finer than 63 μm
Alam Ganj (Swat), fine sand, USNM 417,322	22	0	1	6	6	65	100	100	92	55	38	20	6	2	1
Alam Ganj (Swat), coarse sand, USNM 417,321	74	1	0	3	12	10	99	61	4	1	0	0	0	0	0
Kharmathu (NWFP), USNM 417,541	3	0	0	4	12	81	100	100	98	55	38	19	6	3	2
Shahbaz Ahmed Khel (NWFP), USNM 417,270	4	1	0	3	9	83	100	99	93	71	64	53	36	25	20
Garhi Maqulabad (Gujrat), USNM 417,249	4	0	0	4	4	88	100	100	97	37	15	4	2	1	1
Zakhel Bala (NWFP), USNM 412,415	4	0	0	20	0	76	100	100	98	17	11	7	4	1	0
Pabbi (NWFP), USNM 417,312	3	1	2	42	6	47	100	100	84	13	9	5	2	1	1
Multan (Panjab), USNM 417,195	12	0	0	4	6	80	100	99	99	64	41	21	8	3	2

techniques involving separation of very fine fractions, sieve analysis was used to determine particle size distribution. The original samples, weighing between 0.5 and 5 kg, were divided by quartering to produce a representative sample of about 100 g of sand. Ten grams of this were set aside for mineralogical analysis, the remainder being used for sieve analysis.

Samples for sieve analysis were heated at 100°C to remove all free moisture, and then passed through a stack of sieves placed on a mechanical vibrator. The residue on each sieve was then removed and weighed to give a particle size distribution.

The smaller sample of about 10 g was used to determine the mineralogy of each sand sample. The sample was first subjected to separation of the heavy mineral fraction (SG greater than 2.96) and then the mineralogy of the light fraction determined by grain count using a binocular microscope.

Heavy mineral separation was done by standard methods using bromoethane (acetylene tetrabromide) as the flotation liquid. A glass funnel was fitted with a rubber tube at the bottom; the rubber tube was sealed with a clamp. The funnel was then filled with bromoethane, and the sand sample poured in. After a suitable interval the minerals with SG less than 2.96 floated to the top of the liquid, and the minerals with SG greater than 2.96 sank to the bottom. The heavy minerals were removed by carefully operating the clamp to remove the lower fraction, which was collected in a filter paper below. The light fraction was collected after draining the remainder of the liquid from below; the light minerals were washed from the funnel with acetone and collected in a filter paper. Both fractions were then washed with acetone to remove all traces of bromoethane, and then dried carefully before weighing. This gave the percentage of heavy versus light minerals in the sample. The light fraction was then placed in a squared tray, which was examined under a binocular microscope at a magnification of ×50 to 10. Grain counts gave the percentages of minerals in the following classifications: quartz, felspar, micas, carbonates (including organic materials), rock fragments, and minerals. The results of the mineral analysis, and of the particle size distribution analysis, are shown in Table 8.

Results of Technical Studies.—It will be noted that this method of obtaining a percentage estimate of the content by weight of various minerals makes the assumption that all the minerals included in the light fraction have the same specific gravity. Because in practice this is not so, the results are reported only to the nearest whole number, which is to be taken as an approximate indication only of the relative amounts of the minerals present.

Sands used for glazed pottery are discussed separately from those used for unglazed vessels. Of those used for unglazed vessels, the sands from Kharmathu, Shahbez Ahmed Khel (near Bannu), and Gujrat consist primarily of quartz grains. The Shabaz Ahmed Khel sand also contains a significant amount of felspar (about 10 percent) as does that from Kharmathu; the heavy mineral fraction in these clays is minor.

By contrast, the heavy mineral fraction is the major component on about 75 percent of the coarse sand from Alam Ganj (Swat), and is present in significant amounts in the fine sand (Table 8). It has been noted that the potter in Alam Ganj village, from whom the original sample was obtained, dug sand from a deposit near the bank of the Swat River, and then sieved this to obtain two fractions of "coarse sand" and "fine sand." The present analysis shows clearly that the heavy minerals present in the original deposit are coarser in grain size than the light minerals, and that in sieving the clay the potter was producing two fractions of quite distinct mineralogy. The fine fraction contains 22 percent heavy mineral and 65 percent quartz; the coarse fraction, 74 percent heavy minerals and only 10 percent of quartz, and 12 percent of felspar as opposed to 6 percent in the fine sand.

The preponderance of heavy minerals in the Swat sand samples as opposed to all the other sand samples included in this study may be related to the source of the sand deposits. Swat (pp. 124–126) is a complex geologic region containing igneous and metamorphic rocks of Precambrian age, with Tertiary intrusions of diorites, granodiorites, granites, and syenites. Both the clay and the sand used by the Alam Ganj potter are obtained from alluvial deposits near the Swat River; the clay (Table 6) contained significant quantity of amphibole.

By contrast with the two sand samples from Swat, all other sand samples included in this study were originally obtained by the potters from loess deposits of wind blown sand, or from former flood plain sources associated with the Indus River floodplain system.

In the latter category is the Multan sand used for making glazed ware; this sand also contains a significant percentage of heavy minerals, 12 percent (Table 8). The sample from Zakhel Bala has a high mica content, 20 percent, and that from Pabbi, only 7 km from Zakhel Bala, a very high mica content of 42 percent. None of the samples contain significant identifiable quantities of carbonate.

It is interesting to note that in compounding the body, Pabbi potters use a blend of two parts clay to one of sand; the Zakhel Bala body is nine parts clay to one of sand. This is because the high-mica Pabbi sand would have much less effect in lowering shrinkage of the unfired body, so more is required.

Apart from the coarse sand sample from Swat, and the sample from Shabaz Ahmed Khel, which has a high content of very fine particles, the particle size grading of all other samples is overall quite similar. It is not surprising to find that most of these samples are essentially comprised of particles finer than about 0.2 mm, considering that all these sands are used in bodies for throwing on the potter's wheel. For this, a high content of particles coarser than about 0.3 to 0.5 mm causes difficulty in throwing unless particularly large vessels are being formed.

Thus, because none of the potters use fine sieves to separate fine fractions of sand to be used in throwing bodies, but only sieve the sands in order to remove occasional very coarse particles or organic impurities, it is concluded that these tempering materials were originally selected for use because their natural particle size distribution was appropriate to their intended usage.

Clay and Body Preparation

It is important to note that the body used by all potters in Pakistan is well suited to their forming and drying techniques. No potter spoke of any difficulty in forming ware or vessels cracking during drying except under extreme conditions. Thus a diversity of materials gave a practical, usable material with which the potter could use his own skills.

The method of body preparation is virtually standard throughout Pakistan, with only one major variation in procedure noted in Hala. Otherwise, body for both glazed and unglazed ware is prepared by the following methods.

The clay is brought to the workshop and then spread out on an area of ground, reserved for this purpose, to dry in the sun. If rain is expected the clay is dried under shelter, in which case the drying takes longer than the usual one or two days of sun-drying.

The lumps of dry clay are then broken up, usually with a stout stick, to produce lumps no larger than 2–3 cm, with most of the clay much finer than this. Some potters then sieve this material to remove the larger lumps, which are set aside and crushed finer. In far northern areas, such as Dir, a leather sieve is used, but where sheet metal is readily available potters use sieves made by punching holes in zinc-coated iron sheet.

The amount of clay to be prepared is scooped or shovelled into a conical pile which is then hollowed in the center. Potters who add sand to the clay usually sprinkle some sand on the ground where this pile is formed and then place the clay on top of the sand. In Dera Ismail Khan, Bannu, and Kohat, and in some areas in the Panjab, potters dig a shallow pit in the ground for clay preparation. Through use, this pit gradually acquires a coating of clay which prevents earth becoming mixed with the clay being prepared. Some potters in the far north place clay on a wooden platform or a very large wooden dish, rather than directly on the ground.

Whichever system is used, one characteristic is common. When water is added to the clay, the amount used is just enough to bring the clay to plastic condition, and no more. Thus, although water is plentiful in most areas, it is used sparingly. The only exception to this was seen in Hala, where potters place clay in a drum, or deep pit in the ground, and then covered it with an excess of water.

The time for which the clay is left to be completely wetted by the water varies from a few minutes to 24 hours. In the latter case the potters usually wet the clay in the afternoon and leave it overnight to soak.

When the clay is completely wet, it is kneaded, and nonplastics or temper, if used, are added. The amount of nonplastic sand material to be added is either measured out by volume into a special container, or simply judged by the potter. Only in Multan are the relative amounts of materials weighed out on scales. Since the majority of potters judge the amount by experience, the ratio of tempering material to clay varies considerably in practice. Regardless of the way in which potters decide how much sand to add, the practical method of mixing is to first sprinkle sand on top of the wet, plastic clay and then blend the two materials by foot-kneading, treading around the clay. The clay is alternately trodden out flat, then rolled into a cylinder shape, then trodden again until homogeneous, both in moisture content and in distribution of the temper. The clay body is then ready for storage in the case where potters store it in an underground pit, or for use by potters who prepare and use body only as required.

FORMING AND FINISHING TECHNIQUES

Forming techniques used by specific potters in each village have been outlined. Some of the methods, particularly some hand-building techniques from the far north, were chosen for study because of their unusual nature. Others were chosen for study because vessels made by the method are very widely distributed in Pakistan. An example of the latter is the type of mold-formed water storage jar described from Musazi, near Peshawar. Brief examination of vessels on sale in many bazaars in Pakistan showed that this mold-forming technique is used all over the county, with local variations in shapes of vessel and decoration. In the following discussion the distinction between unusual and widespread forming techniques is made.

In a craft, such as that of the potter, even the humblest practitioner exercises a great amount of skill. To any observer who has not attempted to make pottery, forming operations often appear to happen so effortlessly that it can mistakenly be assumed that "anyone can do it." This illusion is created partly by the plastic nature of the clay, which when soft deforms at the slightest touch, and partly by the skill and experience of the potter in controlling such a sensitive material. Every potter is different, with his individual idiosyncracies. It is obvious that in such a highly skilled activity, these individual characteristics are reflected in work and emerge as style. That this is so is shown by the fact that one of a group of potters can examine a vessel and say which member of the group made it. It is quite artificial to discuss forming techniques without recognizing this individuality. The level of the present discussion only allows extraction of those gross techniques that can be recognized despite the individuality of the potter. There are some quite definite distinctions in forming techniques for unglazed vessels and for glazed ware. Tiles can be omitted from this distinction, because they are produced primarily as glazed ware, and are formed by pressing, with or without a mold. Hollow ware and flatware, on the other hand, are amenable to a much wider variety of forming techniques.

Essentially in Pakistan, all vessels to be glazed are formed by throwing on the potter's wheel (pit-wheel), joining parts if made separately, and turning to final shape.

The range of forming techniques for unglazed ware is much greater, but only one potter of all those making unglazed ware who were interviewed during field studies is forming vessels by throwing and turning.

In workshops where more than one skilled potter is working, forming operations are sometimes divided in such a way that one potter does one operation, such as throwing the initial form of a vessel, and another completes the next, such as shaping the base with paddle and anvil. A further extension of division of labor was seen in Multan, where the potter who forms vessels (*kumhār*) is considered a less skilled craftsman than the man who decorates them (*kāshīgar*).

Before beginning the forming of vessels, potters knead the clay by hand. This produces an even consistency in the clay by distributing water equally throughout the lump. About 5–10 kg are kneaded at one time. Curiously, greater diversity of technique was noted for this operation than for any other in the potters' craft in Pakistan, and it is unrealistic to make any generalizations about it.

Unglazed Ware

The potter's wheel, one or the other of the two main types (pp. 116–119), is used almost universally by Pakistani potters making unglazed ware. The significant exception was noted for *tanur* (bread oven) making; these are formed by a combined coiling, and paddle and anvil technique. A very few potters in the extreme north of Pakistan do not use a wheel (pp. 120–121 for detailed discussion). One of the potters from Chitral uses a combination of coil-building and paddle and anvil forming, beginning the vessel by attaching clay to a hoop and forming the base. After drying, the hoop is removed and the top of the vessel formed. No reference to this unusual working method is known to the writer. Another Northwest Frontier Province potter in Bomboret valley uses a turntable to support and slowly rotate vessels while forming the top, then removes the vessel and completes the base with beater and anvil. Other potters in the Chitral valley form vessels by press-molding the rounded base in any convenient mold, usually the bottom of a broken vessel, and then forming the upper wall by coiling and smoothing with a paddle and anvil.

Essentially, for unglazed ware, the potter's wheel is used only as a means of providing a rough form which can be completed later by further operations.

One technique is limited to the Northwest Frontier Province, where the only type of potter's wheel used is the pit-wheel. The technique, used with vessels that are round-bottomed when complete, involves the

use of a dish-shaped mold, which varies in size according to the size of the vessel being produced.

A specific potter making various sizes of vessels has a large number of molds for each size, a total of 20 to 30 or more. The molds are of biscuit fired clay. In forming a vessel, the potter first places an annular cloth pad on the wheelhead of the pit-wheel. The mold is then placed on this and, with the wheel turning slowly counter-clockwise, is horizontally leveled and centered, by tapping with the heel of the right hand moving away from the body. The potter then sprinkles sand on a flat stone near the wheel and pats out a ball of clay on the sand until it is a flat, circular pad of appropriate diameter. He then lays this pad in the mold, sanded side down, so the edge slightly overlaps the mold. After patting the clay firmly into the mold and trimming the edge with a knife, the potter then adds a coil of clay at the edge of the base-pad and bonds it by smearing the edges of the coil.

Very little water is used at the next stage of smoothing the bottom, centering and raising the coil to form the walls of a vessel. When large vessels are being made, it is necessary to add more coils: each section of the wall of the vessel is thrown, the wheel stopped, a coil added at the rim, and the next section thrown immediately. Potters at Musazi near Peshawar make very large water storage jars by similar methods. When throwing is complete, the mold, with the vessel still inside, is lifted from the wheel and set aside to dry enough for the next stage of working, which is completing the final form with paddle and anvil. With very large vessels, such as those from Musazi, this is done with the round base of the pot still in the mold, so that only the upper walls of the pot are beaten and change shape. The base retains its molded shape. Other smaller vessels are removed from the mold at this stage, and the base is beaten to shape so that in the final stage the form of base and upper section are completely merged in a continuous form.

Demont and Centlivres (1967:43–44) have described similar techniques from Afghanistan, so these techniques that in Pakistan are restricted to the Northwest Frontier Province have a westward extension. The technique of forming vessels in a base mold on the wheel and then completing them afterwards by beating the base, is not referred to from India in the thorough study by Saraswati and Behura (1966).

Another forming method has been described from observations made in the Northwest Frontier Province; with minor variations it is common throughout Pakistan. In this technique vessels are formed in a two-piece, spherical mold. The bottom half of the mold is a hemispherical dish, smooth on the inside; the top half, of similar dimensions and shape, has a hole at the top and a decorative pattern incised on the interior. This pattern becomes relief decoration on the finished vessel. The top and bottom halves of the vessel are formed separately in their respective molds on the wheel, by methods similar to those used with the Northwest Frontier Province base-dish mold already described.

A hole is formed at the center top of the vessel by cutting with a knife from outside the mold. After some drying, the two halves are joined on the wheel; the hole at the top allows the left hand to be inserted inside the vessel, to press clay into the seam and complete the joining with the wheel revolving. The complete mold, with the vessel still inside, then is removed from the wheel, inverted and the bottom mold removed to allow the base and joined area to dry. When leather hard, the base mold is replaced, the vessel again inverted to its normal position, and the top mold removed. By this stage the top has also dried a little. On the wheel, a coil of clay is added around the top opening, and from this the neck of the vessel is thrown. After further drying the completed vessel is removed from the mold.

Variations in this technique were seen in bazaars in many parts of Pakistan: variations of the mold shape from spherical, variations in mold size, and the addition of a thrown foot-ring to the vessel after the removal from the mold, to allow it to stand upright on a flat surface. Vessels formed by this technique in Sind, and also in Baluchistan (Plate 53), have longer, thinner necks than the conventional water pot of the Northwest Frontier Province (Plate 66).

Saraswati and Behura (1966:84–91) described similar molding processes in northern India. According to those writers, however, the potter's wheel is not used at all in the process. The clay is pressed into the mold by hand rather than with the mold revolving on a potter's wheel as in Pakistan. It is difficult to understand why this significant difference exists, considering that before the partition of India in 1947 contact between Pakistan and the northern areas of India was unhindered by political barriers. It is suggested that the distinction more clearly points out the association which has been made (p. 117) of the pit-wheel with Muslim potters, who use the wheel in this forming technique, as opposed to the Indian potters, whose technique is basically identical except that they do not use the wheel. Other than that it is not possible at this point to determine whether the Muslim pit-wheel users adapted an essentially hand-molding technique for wheel use, or whether the

Indian potters developed their techniques from Muslim influences.

A technique not noted elsewhere in Pakistan is used in the village of Shadiwal, near Gujrat, where many potters are producing large flat-bottomed dishes (*kunālī*). A dish is thrown on the wheel, then cut off so the bottom is removed. After drying to leather hard the bottom is formed by beating down excess material from the sides with an anvil-like fired clay tool.

This technique of throwing a "bottomless" vessel and then closing the base with beater and anvil was described by Saraswati and Behura (1966:58–61), who identify it with southern India. They describe a technique in which the potter throws a form with completed rim on the potter's wheel, removes it with the base in place, and then beats out the base to a rounded shape. This technique is used for water storage jars in various parts of Pakistan, including Dera Ismail Khan and Karachi (p. 51).

These techniques are confined mostly to potters making glazed ware, with one exception. The potters of Ahmedpur East near Bahawalpur use combinations of throwing, turning, molding, carving, and joining separately made pieces to produce the decorative, light-weight unglazed ware for which Pakistanis have high regard. It is important to note that the paperfine ware of Ahmedpur East is quite distinct from most other unglazed ware in Pakistan, in that it is essentially decorative rather than functional. Its forms appear very closely derived from Islamic pierced metal-ware.

It is difficult to compare the output of pottery resulting from different techniques. Potters only produce vessels which can be sold, so output is to a large extent dependent on the market. The specialist potters, those producing a limited range of ware to distribute over a wide area, have a more consistent production than village potters who produce a wide range of ware for sale to the local villagers. When asked to estimate the maximum possible output on the basis of a fixed period of time so that clay-getting, firing, and other activities could be included, potters gave the following estimates: technique involving throwing initial form of round-bottomed water jars on wheel, completing with paddle and anvil, 40 to 50 per day; techniques involving throwing similar sized vessels, completing by turning, up to 100 per day. In practice production was almost always less than this.

Glazed Ware

In contrast with unglazed ware, the range of forming techniques used by glazed ware potters in Pakistan is very limited. Tiles are formed in large quantity by pressing out plastic clay and cutting it to size, trimming and smoothing afterwards. In smaller quantities tiles are pressed into molds, which may have special shapes other than square or rectangular. Tiles are decorated by carving at leather hard. Perforated or screen tiles have the open section cut out with a knife at leather hard.

Although glazed ware vessels from different production centers have quite distinct forms, the basic forming techniques are similar. The pit-wheel is used for almost all vessels. Forms are thrown, dried to leather hard, and then turned to refine and complete the form. Foot-rings are formed during the turning operation.

Many vessels of complex form are built up from a number of pieces. Individual parts of the form, such as neck, center and pedestal foot for a vase, are thrown separately. These parts are dried to leather hard and then joined together on the wheel, using plastic clay for the joint.

A refinement of this technique is used to produce double-walled vessels, such as those made by potters near Peshawar. Two forms, one of which fits inside the other so that they touch around the rim, are made on the wheel and fitted together at leather hard. The vessels are completed by addition of a separately thrown neck and foot. The outer wall is then perforated in a decorative pattern. When fired the inner wall contains liquid.

Minor parts of vessels, such as handles and knobs, are joined to leather-hard vessels. If plastic decoration, such as incised or impressed patterns, are used, these are also applied when vessels are leather hard.

The use of the pit-wheel for glazed ware forming suggests the Islamic origins of these traditional wares. It is beyond the scope of this monograph to attempt any discussion of the origins of glazed ware in Pakistan. In relation to forming techniques the above discussion of the pit-wheel (p. 116) is relevant.

Conclusions

Techniques for forming unglazed ware and glazed ware in Pakistan are essentially different, and only very few potters making unglazed ware use characteristic glazed ware techniques. The range of techniques for forming unglazed ware is much greater than for glazed ware. The essential glazed ware techniques are throwing and turning, or throwing separate parts of a vessel and joining.

For unglazed ware, techniques used in the Northwest Frontier Province are not used in other parts of Pakistan, but can be related to techniques used in Afghanistan. They include throwing a water pot on

the pit-wheel with a base mold, then completing the vessel with paddle and anvil. Other techniques involving throwing, and paddle and anvil finishing are similar to some methods used in northwest India; these extend from west to the Indus, through Panjab, and into Sind. They involve the throwing of a vessel with thick lower walls and the subsequent enlarging of the base and lower walls with paddle and anvil.

Another common forming technique, forming water pots in a two-part mold, has parallels in India except that Pakistani potters use the pit-wheel to revolve the mold; Indian potters use hand-molding. Other techniques, particularly that of Ahmedpur East of making paperfine ware are either specific to a specialized ware type, or appear to be specific to a very limited number of potters.

SLIPS, PIGMENTS, AND COLORANTS

Terminology and Uses

In the report of field observations, a variety of decorative techniques were recorded. The following discussion is limited to the decoration of vessels or tiles with ceramic colors. The terms "slip," "pigment," and "colorant" have acquired a range of meanings in archeological literature, so the specific meanings applied in the present work have been given in the glossary but are expanded in the following section to avoid misunderstanding.

SLIPS.—A slip may be described as an overall mineral coating, usually containing a high percentage of clay minerals applied before firing. The clay minerals in the slip cause it to fit well on a vessel or tile to which it is applied because of the similar firing characteristics to the body, apart from color. The slip is used to give the vessel a color which is considered better than that of the body. It is also used to give an improved ground for brushwork decoration, particularly in the case of glazed ware. In contrast to glazes, slips do not vitrify significantly during firing, that is slips do not become "glassy."

The application of slips is always left until vessels or tiles are completely dry (bone dry). Three methods are used for overall application: wiping slip on with a cloth, most common in the northern regions; dipping vessels into the slip; and pouring it over vessels. Dipping and pouring are common in the Panjab and are also the standard methods of application of slip for glazed ware. For all three methods the slip batch is prepared as a thin suspension of the slip minerals in water.

Colors of slips applied to vessels or tiles tend to be characteristic for different regions of the country, with the exception that a red slip is used on unglazed ware all over Pakistan. In the north the red color is used almost exclusively for unglazed ware; around Peshawar white slips are also used. In some areas west of the Indus a slip having the same composition as the body is used in conjunction with finger-trailed decoration applied to the slip coating while it is wet. Combinations of different slips on the same body are rare and limited to the case where a basic slip coating is applied as a background and then contrasting slips are applied by brushing. For unglazed ware this use of two slips is most common in the southern parts of the county, in Sind and lower Panjab. In these areas micaceous slips are also commonly used, most notably on the fine ware of Ahmedpur East.

For glazed ware the slip combinations used are quite characteristic of the traditional centers of production, and need not be reiterated in detail here. Slips used for high-lead glazes appear from field studies to be distinct from those used in alkaline glazes, the former having a high clay-mineral content and the latter having a high-silica content.

A curious anomaly is worthy of note. Many potters in the far north of Pakistan decorate cooking vessels with a red slip and often with black pigment brushwork applied over the slip. Subsequently, in use the cooking vessel becomes completely blackened by smoke from the cooking fire. Several potters, when asked why they bothered to do the decoration, simply answered that their customers would not buy the vessels if they were not decorated; it was "what they had come to expect." It is possible that some blackened cooking pots now in collections from archeological sites may be similarly decorated.

PIGMENTS.—Pigments may be described as minerals or mixtures of minerals containing elements, such as Fe, Mn, Cu, which produce colored decoration after firing. The term is confined in the present work to those materials which, after crushing and fine grinding, and suspension in water, are applied to vessels, often over slips by brushing. The decoration thus takes the form of lines, bands, or washes, and in the most sophisticated forms contains a complex variety of decorative patterns which can be abstract or derived from natural forms.

The basic pigment color for unglazed ware in Pakistan is black, applied over a red slip background;

in the far north this combination is the only one used. Around Peshawar black pigments are applied over both red and white slips. Further south in the Panjab and Sind the pigment palette become more varied, with white, red, and black commonly all used on one vessel. These combinations are characteristic in Ahmedpur East, but brief examination of pottery on sale in Sindhi bazaars showed that they are certainly not restricted to that area.

All pigment decoration on glazed ware in Pakistan is applied under glaze. That is, first a slip, if used, is applied to the dry vessel. After the slip is completely dry, the brushwork decoration with pigment is applied. When this in turn is completely dry the glaze can then be applied. Overglaze decoration is not used on any of the traditional glazed wares, although its use was noted in some of the wares produced under modern European influence, which, however, is not relevant to these studies.

COLORANTS.—This term is commonly used in the literature of glass and glaze studies, and refers to elements, or compounds containing those elements, which give glazes their color. In the absence of a colorant, a glass or glaze will be clear, that is colorless; color is obtained by the presence of elements such as Fe, Cu, Mn. Usually small amounts of colorant are present in a glaze batch as impurities, naturally occurring with the raw materials. In the present context the term "colorant" refers primarily to those materials that are added to a glaze batch to give the glaze its fired color.

It is entirely possible that a pigment, as defined here, could be used as a colorant. An example of this from Pakistan is the green colorant (USNM 412,462) from Zakhel Bala, which is used in both ways. Colorants in Pakistan are mixed uniformly with the glaze batch before application of the glaze to vessels or tiles.

Potters in Pakistan who make glazed ware display a more sophisticated knowledge of pigments and colorants than potters who make unglazed ware. During field work, questions to potters on the nature of material used as pigment or colorant received quite distinct answers. Potters making unglazed ware described pigments as "black color," and "red color," etc.; whereas potters who make glazed ware described pigments or colorants in terms such as "copper scale," "cobalt oxide." This is partly to be expected as the makers of glazed ware have almost universally had some influence from technical advisors of one kind or another. Significantly, the potters generally reject the advice and tend to be very resistant to changes unless there is overwhelming economic or other reasons for changing their techniques.

Analytical Studies

To learn more about decorative materials employed by Pakistani potters, laboratory analyses were made of samples collected in Pakistan and now in the Ethnology collections of the Department of Anthropology, Smithsonian Institution. In the following discussion these samples are identified both by their place of origin and their catalog number in the Smithsonian collections; all are also listed in Appendix 1.

SLIPS.—Three methods for applying slip are used in Pakistan: wiping on with a cloth, dipping, and pouring. The first, used mainly in the far north, is used for applying red slips to unglazed earthenware. The preparation of slip for this method of application is distinct from that for the other two methods. The raw material for the slip, usually in the form of a claystone or mudstone, is placed in water in a suitable container, often a broken vessel, and broken up roughly. The material is then mixed roughly so that some is suspended in the water, and stirred with the cloth each time it is dipped in the slip. The wiping action of the wet cloth across the vessel gives an even coating of slip as it is applied.

For dipping or pouring, slips are mixed to an even consistency. Vessels to be coated are dipped in slip held in a large container; commonly, and especially with glazed ware, slip is poured over parts of a vessel which cannot easily be submerged in the batch of slip.

For both dipping and pouring, it is essential that the slip materials remain in suspension in water, without settling of solid particles. The agitation caused by dipping, or pouring from a small container over the vessel, so that excess runs back into the large container, assists slightly in keeping the slip in suspension. It is also necessary that the raw material for the slip should have a high content of clay minerals and a relatively high content of fine particle size minerals. Observation of slip batches in the workshops of potters in Pakistan indicate that materials used as red slips on unglazed wares do indeed have a significant content of plastic clay minerals. When dried the slip forms a hard, compact, mudstone-like aggregate, and when in suspension in the slips have a distinctly plastic feel. Some slips, however, notably the micaceous slip in use in Ahmedpur East, apparently have little or no significant clay mineral content. When this slip is mixed into a suspension for applying to vessels by pouring (Plate 41*a*) the finely ground mica particles settle quickly and the slip batch has to be constantly stirred to keep these particles in suspension. Examination of a

sample of this micaceous material from Ahmedpur East (USNM 410,652-A) with a binocular microscope showed that the raw material consists almost entirely of plates of white mica, probably muscovite.

Two samples of slip materials have been submitted to x-ray diffraction analysis (Table 6). The two samples are a yellow clay from Garhi Maqbulabad which is widely used by Panjabi potters as a red slip on unglazed ware (USNM 417,250) and a brownish colored mudstone which is mixed and suspended in water for application as a slip on Quetta glazed ware (USNM 414,553); the latter fired to a brown color.

The x-ray diffraction study showed the Gujrat material to consist of kaolinite and quartz, with illite, calcite, and potash felspar; and Quetta slip material consists of kaolinite, illite, and quartz. None of these minerals contain enough iron or other elements that could account for the red and brown, respectively, fired colors of the slips; that is, about 5 percent or more of iron oxide, or equivalent.

It is suggested however, that the coloring oxides, presumably primarily iron, could be present in either or both of two forms which could not be detected by x-ray diffraction. Iron could be present in the form of ochres, hydrated iron oxides, which occur as extremely fine divided aggregates; the yellow color of the Gujrat slip is especially suggestive of this possibility. Iron could also occur as iron coatings on grains of the minerals which were detected by x-ray diffraction, and in this form could be present in amounts of up to 2–3 percent of iron. Further study is required before the composition of these slip materials is completely determined.

Apart from the common fine red slip decoration, some unglazed ware makers use unusual slip materials. The potters of Kharmathu, near Kohat in the Northwest Frontier Province, apply a slip which has the same composition as the clay body used to make vessels; this slip is only used on some of the larger vessels. As with the body, the slip was composed of clay, sand, and salt (NaCl). Potters in Dera Ismail Khan use a slip based also on clay, sand, and salt, but in their case the slip is made up independently of the body, which is composed of clay without admixture. A mineralogical study of the sand (USNM 417,233) used in slip by Dera Ismail Khan potters showed it to consist of: quartz 90 percent, micas 5 percent, other minerals 5 percent. The mineralogy of the clay is reported in Table 6; it has a complex mixture of clay minerals with quartz, calcite, and plagioclase. So the slip is basically a mixture of clay, fine quartz, and common salt. Both the Kharmathu and Dera Ismail Khan potters said that this type of slip is used on water storage vessels because it keeps the water cooler. As previously discussed, the Ahmedpur East potters also use a somewhat unusual slip material, finely ground white mica.

Slips for application to glazed ware vessels before application of the glaze ware are basically of two types. For the application of slips under lead glazes at Hala and Peshawar, the slips are suitably colored clays, mixed and suspended in water for application. Slips for use with alkaline glazes, as at Hala and Multan, are siliceous; the slip used at Hala is ground flint, a hydrated silica. The slip used at Multan was 75 percent quartzite, with 25 percent plant ash. Examination of a sample of the quartzite (USNM 417,197-A) from Multan showed it to be composed primarily of crystalline quartz, with accessory amounts of white mica. Because these siliceous slips contain no clay it is necessary to mix them with an organic flour glue, such as flour paste, for application.

PIGMENTS AND COLORANTS.—For unglazed ware in the Northwest Frontier Province, Panjab, brushwork decoration is usually only in one color, black. At Ahmedpur East, the Bahawalpur paperfine unglazed ware is decorated in three pigment colors: white, red, and black; these three colors are also used on some Sindhi unglazed ware. Potters making glazed ware use a wider range of pigments, as well as colorants that are added to the glaze batch in order to uniformly color the glaze. In order to evaluate the composition of samples of coloring materials in the categories just mentioned, samples were tested by optical emission spectroscopy analysis in the Conservation Analytical Laboratory, Smithsonian Institution. All the samples, in the collection of the Department of Anthropology, Smithsonian Institution, were collected in Pakistan from the potters who used them and are listed in Table 9. According to the potters, they are representative of the materials in normal use.

About 5–10 g of each material were submitted to the analyst, who reduced each to 5 mg for the analytic sample. The results of the analysis, in which 41 elements were sought, were presented as semiquantitative tables, with reported values expressed as a percentage valid within plus or minus 50 percent of the reported value. The data has been modified for clarity in the form of presentation appearing in Table 9.

Considering that the limit of quantitative accuracy of the original data was plus or minus 50 percent, it will be seen that in this table some of the elements in the two groups coded as "o" and "x" are not definitely placed in one of these groups but could appear in the other. However, the other categories are in accordance with the accuracy of the original data, and serve to show what is required here, that is, which elements

contribute primarily to the coloring power of the pigment or colorant.

It can be seen from Table 9 that the two black pigments for use on unglazed ware from Swat (USNM 417,325) and Dera Ismail Khan (USNM 417,236) owe their black color to the presence of iron and manganese. In the Swat material these two elements are the only ones indicated as being present in amounts more than one percent, so it appears that the pigment was obtained from a relatively pure ore source. By contrast the Dera Ismail Khan pigment is of much more mixed composition, and possibly composed of an iron and manganese ore mixed with clay, which is the source of Al, Ca, and Si in the analysis. If so the clay would be beneficial to the application of the pigment materials; when mixed with water it would suspend and brush more readily.

Comparison of the three pigment materials from Ahmedpur East for Bahawalpur ware shows that the white pigment (USNM 410,652-B) contains only minor amounts of iron and manganese; the red pigment (USNM 410,652-C) contains a significant ("significant" referring in the present context to elements present in amounts greater than one percent) amount of iron, and only an insignificant amount of manganese in terms of coloring power; whereas the black pigment (USNM 410,652-D) contains both iron and manganese in amounts which would contribute significantly to coloring power. The analyses suggest that the white pigment may be simply a white firing,

TABLE 9.—*Optical emission spectroscopy analysis of elements present in pigment and colorant materials from Pakistan*

SAMPLES	ELEMENTS																
	Al	Ba	Ca	Co	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Si	Sn	Zn	Other elements 0.1 - 1.0%
Black pigment, Alam Ganj, Swat, NMNH 417,325	x	x	x	o	o	X	o	o	X	o	o	x	o	x	o	ND	
Black pigment, Dera Ismail Khan, USNM 417,236	X	o	X	o	o	X	x	x	X	x	x	x	o	M	o	x	Sr,Ti
White pigment, Ahmedpur East, USNM 410,652-B	X	o	x	ND	o	x	x	o	o	o	o	ND	o	M	o	ND	
Red pigment, Ahmedpur East, USNM 410,652-C	X	o	x	o	o	X	X	X	x	x	o	x	o	M	o	ND	
Black pigment, Ahmedpur East, USNM 410,652-D	x	o	x	x	o	X	o	X	X	o	x	x	o	X	o	x	
Brown colorant, Quetta, USNM 414,556	X	x	x	o	x	x	o	x	X	x	x	ND	x	x	x	X	Au,Ti
Copper scale for green glaze, Quetta, USNM 414,557	X	o	X	ND	M	X	x	x	x	x	x	ND	x	X	X	X	B
Blue pigment, Zakhel Bala, USNM 412,463	X	o	x	M	x	x	x	x	o	x	x	X	x	X	o	ND	Ti
Green pigment and colorant, Zakhel Bala, USNM 412,462	x	x	x	ND	M	x	x	x	o	x	x	o	x	X	X	X	
Brown/black pigment, Zakhel Bala, USNM 412,461	x	X	X	o	x	X	o	o	M	o	x	x	x	x	o	x	As,Au
Copper scale for turquoise color, Multan, USNM 417,197	o	o	x	ND	M	x	x	x	o	x	x	x	x	X	X	X	

ND = sought but not detected; o = reported as less than 0.1 percent; x = reported in range 0.1 - 1.0 percent; X = significant amounts reported as greater than 1.0 percent concentration; M = reported as major constituent.

Note: The following elements were also sought by the analyst and not detected in any sample: Bi,Cd,Ga,Ge,Pt,Rb,Sc,Tl,W,Cs,Nb. Other elements (Ag,Be.Cr,Hg,Li,Mo,Sb,V,Zr) were present in some samples in amounts reported as lesser than 0.1 percent.

relatively pure clay; inspection of the sample itself confirms this conclusion. The red pigment may also contain significant quantities of clay minerals.

One point which emerges from the analyses of these five pigments for unglazed wares is that in order to obtain a black color, the potters chose a pigment material which contains manganese. The fired wares on which they are used have reddish colors, indicating that the iron is present in oxidized form (as ferric oxide, Fe_2O_3). In other words, if coloring elements (Fe, Mn) are low or absent, a white color is obtained, if iron is present in sufficient quantity a red or red-brown color is obtained, and if iron and manganese are both present in significant quantity, a black color is obtained. On such wares, where there is no appreciable vitrification of the body or decorating materials in the firing, the color of the pigment will be influenced by cooling, as well as by the heating atmosphere. The fired colors of vessels on which the five pigments discussed above were used indicate that the vessels were in an atmosphere containing excess air while at high temperatures and during cooling.

For discussion the pigments and colorants used for glazed ware may be grouped according to their fired color. The two brown colorants, from Quetta (USNM 414,556) and Zakhel Bala (USNM 412,461), both contain significant amounts of manganese; the Zakhel Bala material also contains a significant amount of iron. Apart from the manganese content, which the two materials had in common, they were otherwise quite different. The Quetta brown colorant is a manufactured rather than a natural material; it was produced by crushing the core of dry cell batteries (p. 74); the significant constituents of this material are Al, Mn, and Zn.

The Zakhel Bala pigment is a natural material, for which the only preparation before use was grinding. Its fired color on vessels varied from brown to black by varying the thickness of the application. It contains manganese as a major constituent, with significant amounts of iron (Fe), barium (Ba), and calcium (Ca); it is the only one in the range of samples which contains barium as a significant constituent. Apart from its use on glazed ware it is also used on unglazed vessels as a black pigment.

The blue pigment used at Zakhel Bala (USNM 412,463) was obtained commercially from Gujrat, where it is sold as cobalt oxide, according to the potters. Its composition shows Co as the major constituent, but significant amounts of Al, P, and Si are also present, suggesting that the material was not refined but sold in the form in which it occurs naturally.

The three pigments which were described by potters as copper scale or the black scale or oxide forming on the surface of copper when it is heated to red heat and then cooled, all proved to have Cu as a major constituent. The copper scale from Zakhel Bala (USNM 412,462) and that from Multan (USNM 417,197) are remarkably similar in composition. Both contain Si, Sn, and Zn in significant quantity; the Sn and Zn are present as impurities in the copper. It is very common practice in Pakistan for metals such as copper to be reused. New copper vessels, for example, are made from metal recovered from old or worn-out vessels. Many copper vessels—for example, those used in preparing food—are coated with tin, with which it is possible that zinc and lead are mixed. These metallic elements have thus been incorporated in the copper scale used by potters. The significant Si content may also be attributable to the impure source metal, although it is much more likely to have been introduced during preparation, from the grinding stone.

The copper scale from Quetta (USNM 414,557) is more complex in terms of its content of significant elements. In addition to the elements present in significant quantities in the Zakhel Bala and Multan copper scale samples, the Quetta copper scale contains significant amounts of Al, Ca, and Fe, which suggests that some clay may have been added to the material or at least was present as an impurity.

It should be noted that, despite the similarity in composition of the Zakhel Bala and Multan copper scale materials, they produce quite distinct colors on the glazed ware from these two centers. At Zakhel Bala the copper scale produces a bright green color in glazes, whereas at Multan the copper scale is used to produce a turquoise color. The difference is that at Zakhel Bala a lead glaze with copper scale added to the batch as a colorant is used, whereas at Multan the glaze is alkaline and the copper scale is used as an underglaze wash. The same colorant material produces quite distinct colors which are dependent on composition of the glaze with which they are used and on their concentration. The copper scale from Quetta, used to color glaze similar to that of Multan produces a color intermediate between the other two. The difference in color results from the use of different glaze raw materials, different slips (dark on Quetta ware, white on Multan) and the use of the copper scale as a colorant in the Quetta glaze contrasted with the use of copper scale as a washed pigment under the glaze in Multan.

Conclusions from Study of Pigments and Colorants

All samples of pigment and colorant materials are of relatively complex composition, and none were refined to reduce the compostion to that of the one or two elements which contribute most to the coloring power of the material.

Pigments which are used for black decoration on unglazed ware contained significant amounts of manganese in addition to iron, whereas iron was the major colorant in a sample of red pigment; neither iron nor manganese is present in significant quantities in a sample of white pigment. Materials containing significant amounts of both iron and manganese are used to produce either a black or brown color depending on the thickness of the coating applied.

Pigments produced from metallic copper contain significant amounts of other elements which could be attributed to the impurity of the original source metal, tin and zinc being the two main such elements.

GLAZES: LABORATORY STUDIES

The techniques of manufacturing traditional glazed ware from four centers have been discussed, those centers being Quetta, Zakhel Bala and Pabbi, Multan, and Hala. Restriction of studies to those centers does not mean that glazed ware is not produced elsewhere in Pakistan; it indicates that the potters whose work has been discussed here were minimally influenced by outside industrial developments. Potters also are known to be producing traditional glazed ware in other centers, such as the Gujrat-Gujrawala-Sialkot district, in Panjab, and at Thatta, in Sind. A popular type of glazed ware, formed by casting, and glazed in 'splashed ware' style, is produced in Peshawar city. Agencies of the Pakistani government are assisting in the establishment of modern ceramic industries (Faruqi, 1970:197–198, 200–201), mainly centered in Karachi.

Stylistically, wares from these four centers of Quetta, Zakhel Bala, Multan, and Hala are easily distinguished from one another. The Quetta ware has a pale, buff-colored body, brown slip and monochrome glazes, usually brown or green. Brushwork decoration is not used. The forms are direct and have a simple, strong character (Plate 54).

The Zakhel Bala ware has a pinkish red body, with both overall and brushwork slips and pigment brushwork under the glaze. A variety of color combinations is achieved by varying the combination of a limited range of materials; these combinations have been detailed in Table 2.

Multan ware also has a reddish body, a characteristic white siliceous slip, and blue or turquoise underglaze brushwork decoration, with a clear glaze. The brushwork decoration consists of stylized floral motifs on all vessels and most tiles; some tiles have geometric motifs. Vessels and tiles from different workshops in Multan have an overall similarity in the quality of the floral decoration.

By contrast, the alkaline-glazed ware of Hala tends to be more variable from one workshop to another. Some tiles from Hala, with white slip, blue, turquoise, and green brushwork and clear glaze, appear very similar to Multan work, although the sparing use of green pigment in Hala is distinctive; this bright leaf-green color is not used in Multan. Both lead and alkaline glazed ware from Hala have a pinkish body; the lead-glazed ware is decorated with slips, both as overall coatings and as brush-applied floral motifs. The Hala lead-glazed ware is easily distinguished from Zakhel Bala ware stylistically; tiles are not made at Zakhel Bala, and vessel shapes and decorative styles from the two areas are distinctive. The stylized floral decorations of Zakhel Bala are applied in coarse, strong brush strokes (Plate 68); Hala lead-glazed ware is decorated with finer but still lively brushwork (Plate 78). This applies also to the decoration on Hala alkaline-glazed ware, which appears much more alive and spontaneous than that of the somewhat formalized and rigid Multan decorations (cf. Plates 75, 77).

It is possible to note relationships between the present-day traditional glazed wares of Pakistan and those of Islamic wares of earlier periods and localities, but at the time of writing no detailed comparisons are available. Indeed, the origins of the styles and techniques of traditional glazed ware in Pakistan are largely unknown and, apart from a few speculations in the literature, unsupported by positive evidence.

Some comparisons may be made between the traditional glazed wares of Pakistan and wares produced in neighboring countries. The glazed ware of Delhi and Jaipur in India have a superficial resemblance to the alkaline glazed wares of Multan and Hala. Both, however, have a white siliceous body as compared to the red or pink body of the Multan and Hala wares. The techniques of manufacturing Jaipur ware have been outlined by Dhamija (1964:43, 46). Delhi and Jaipur wares often have the blue, tur-

	QUETTA	ZAKHAL BALA and PABBI	HALA	HALA	MULTAN
LOCALITY:	(alkaline-lead glaze)	(lead glaze)[1]	(lead glaze)[2]	(alkaline glaze)[2]	(alkaline-lead glaze)
BATCH COMPOSITION[3]:	57.14% glass (cullet) 28.57% borax ($Na_2B_4O_7.10H_2O$) 7.14% red lead (Pb_3O_4) 7.14% colorant (Cu or Mn compounds)	80% red lead (Pb_3O_4) 20% quartz sandstone or 77% red lead 23% quartz sandstone	68.75% red (Pb_3O_4) 31.25% quartz sand	50% soda ash ($Na_2CO_3.10H_2O$) 50% quartz sand	50% plant ash 50% quartzite
PREPARATION:	Powders mixed ↓ Application	Heated in crucible ↓ Frit ↓ Crushed to powder ↓ Application	Heated in crucible ↓ Frit ↓ Powders mixed ↓ Application	Heated in crucible ↓ Frit ↓ Crushed to powder ↓ Application	Powder pressed into balls, heated in firebox of kiln to sinter ↓ Borax, cullet, lead oxide may be added ↓ Heated in crucible ↓ Frit ↓ Crushed to powder ↓ Application

1 Note that lead oxide used in Zakhel Bala is prepared by roasting lead in an oxidizing furnace.

2 There is conflicting evidence about proportions of materials in Hala glaze batches.

3 Batch composition expressed as percentage by weight (from compositions given by potters as "parts by weight." Note that in practice the precision of weighing would not correspond to this degree of accuracy.

FIGURE 37.—Composition of glaze batch materials and sequence of preparation.

quoise, and white colors of Multan and Hala alkaline glazed ware, but other colors are also in use. The closest resemblance is found by comparing the floral decoration of Multan and Jaipur wares; otherwise the wares are easily distinguished.

The lead-glazed wares of Zakel Bala and Pabbi do not have any direct parallels in neighboring countries, and because of their dissimilarity of style to any other wares of Pakistan, appear to constitute a distinct group. Similarly the Hala lead-glazed ware shows no direct parallels with other wares within Pakistan or in nearby countries.

The Quetta glazed ware is similar in some respects to wares from Afghanistan, described by Demont and Centlivres (1967). These writers collected glazed and unglazed ware in northern Afghanistan; their collection is now in the Ethnology Museum in Geneva, Switzerland. The body of Quetta ware fires to a buff (Demont-Centlivres' "beige," 1967:43) color, as with many of the Afghan wares. Vessel shapes are very similar in some cases; for example, compare No. 33735 from Pul-e Zumri (Demont and Centlivres, 1967:36), and USNM 414,547 from Quetta (Plate 54*a*). From the Demont-Centlivre (1967:35–36) collection, wares from Tashqurgan (No. 33706) and Pul-e Zumri (No. 33737) are most closely related in shape and fired color to Quetta wares. The strong, direct workmanship of the Quetta potters is also evident in wares from Afghanistan nearer to Quetta, for example from Kandahar (Matson, pers. comm.). A detailed comparison of Quetta wares with wares from Afghanistan would certainly show many more parallels.

Because glazed ware from only four locations in

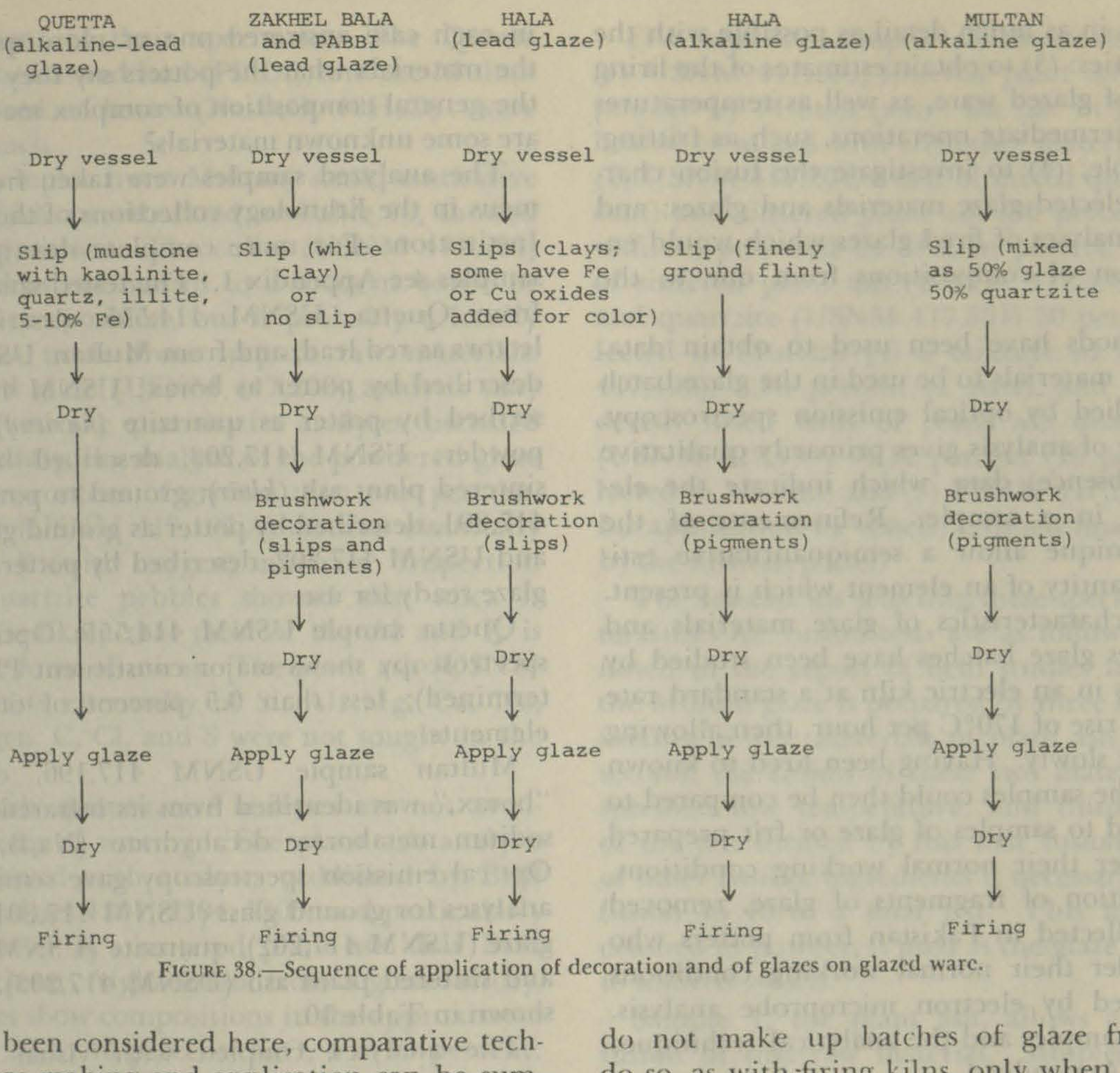


FIGURE 38.—Sequence of application of decoration and of glazes on glazed ware.

Pakistan has been considered here, comparative techniques of glaze making and application can be summarized briefly. Glaze preparation is summarized in Figure 37. Application processes, including glazing, are summarized in Figure 38. These figures are self-explanatory, but several points may be noted. In Figure 37 it can be seen that two of the three lead-glaze processes of Quetta and Hala involve no fritting, which greatly simplifies the preparation but increases the risk of lead poisoning to both potter and customer.

None of the glazes has any clay in the batch, which indicates some difficulty in suspending the powdered glaze in water for application. In practice this is overcome either by constant stirring of the glaze suspension, or by forming a thick suspension with flour glue, as in Multan. The sequence of application of slips, brushwork decoration, and glazes is summarized in Figure 38; note that before application of any slip, pigment, or glaze, vessels are completely dried. All vessels are fired only once.

Laboratory Data

During the field studies it was difficult to study glazemaking in as much detail as desired. Potters do not make up batches of glaze frequently, and do so, as with firing kilns, only when the scheduling of their work requires it. Only in one case, with the potters of Quetta observed by Godden, was it possible to actually watch potters go through the complete process of making and applying glazes from beginning to end.

A further problem during the field studies reported in the present work was that no means of measuring temperature was available to the investigators. Because potters in Pakistan assess temperature by judging flame colors in the kiln, they could not give estimates of temperature in degrees, but could only describe the color of flames (Appendix 2), and the characteristic appearance of vessels in the kiln at the glaze-maturing temperature. It was difficult to interpret their descriptions because their judgments are intuitive, based on experience, and not usually verbalized in the course of their work.

For both these reasons, as well as others, glaze making materials and fired vessels were collected. Laboratory work aimed at verifying and extending the filed data has been completed. Primary aims were: (1) to verify the description of glaze making given by potters; (2) to investigate the composition of

glaze materials in as much detail as possible with the available facilities; (3) to obtain estimates of the firing temperatures of glazed ware, as well as temperatures involved in intermediate operations, such as fritting, where applicable; (4) to investigate the fusion characteristics of selected glaze materials and glazes; and (5) to obtain analyses of fired glazes which would enable comparison of compositions from one to the other.

Several methods have been used to obtain data. Samples of raw materials to be used in the glaze batch have been studied by optical emission spectroscopy. This technique of analysis gives primarily qualitative (presence or absence) data, which indicate the elements present in a sample. Refinements of the analytical technique allow a semiquantitative estimate of the quantity of an element which is present.

The fusion characteristics of glaze materials and in selected cases glaze batches have been studied by heating samples in an electric kiln at a standard rate of temperature rise of 170°C per hour, then allowing the kiln to cool slowly. Having been fired to known temperatures, the samples could then be compared to one another and to samples of glaze or frit prepared by potters under their normal working conditions.

The composition of fragments of glaze, removed from vessels collected in Pakistan from potters who fired them under their normal working conditions has been studied by electron microprobe analysis. Preparation of samples and the analytical techniques are discussed in Appendix 4.

Because these studies, approached by various methods, of Pakistan glazing techniques are all closely interrelated, they are not rigidly divided for discussion. Neither has equal emphasis been given to the study of techniques in different areas; for example the study of lead glazes used in Hala and Zakhel Bala and Pabbi has been brief because these techniques are relatively straightforward, whereas the study of Multan glazes has been much more extensive.

The first part of the report on the experimental work summarizes data obtained from optical emission spectroscopy analysis of glaze materials. The second part reports on studies of the fusion behavior of materials, which have allowed estimates of temperatures involved in the preparation of frits and the firing of glazed vessels and tiles. Finally, the discussion centers around analytical studies of glaze samples from fired vessels and tiles.

Emission Spectroscopic Analyses of Glaze Materials

Six samples of raw materials, to be added to the glaze batch, were selected for analysis. The analysis in each case answered one or more questions: Are the materials what the potters say they are? What is the general composition of complex materials? What are some unknown materials?

The analyzed samples were taken from the specimens in the Ethnology collections of the Smithsonian Institution. For more complete descriptions of the samples see Appendix 1. The tested samples include: from Quetta, USNM 414,555, described by collectors as red lead, and from Multan, USNM 417,196, described by potter as borax; USNM 417,197-A, described by potter as quartzite (*karund*), crushed to powder; USNM 417,203, described by potters as sintered plant ash (*khār*), ground to powder; USNM 417,201, described by potter as ground glass or cullet; and USNM 417,202, described by potter as powdered glaze ready for use.

Quetta sample USNM 414,555: Optical emission spectroscopy shows major constituent Pb (O not determined); less than 0.5 percent of other metallic elements.

Multan sample USNM 417,196, described as "borax," was identified from its infrared spectrum as sodium metaborate decahydrate ($Na_2B_4O_7 \cdot 10H_2O$). Optical emission spectroscopy gave semiquantitative analyses for ground glass (USNM 417,201), powdered glaze (USNM 417,202), quartzite (USNM 417,197-A), and sintered plant ash (USNM 417,203). Values are shown in Table 10.

The analyses, coupled with visual and microscopic examination of some samples, indicate that there is no reason to disbelieve the collector's or pot-

TABLE 10.—*Optical emission spectroscopy analysis of glaze materials gathered by Multan potters*

ELEMENT	GROUND GLASS	POWDERED GLAZE	QUARTZITE	SINTERED PLANT ASH
Si	M	M	M	M
Al	1.00	1.00	1.00	1.00
Fe	0.15	0.20	0.15	0.20
Mg	1.00	1.00	0.30	1.00
Ca	1.00	1.00	1.00	1.00
Na	1.00	1.00	0.70	1.00
K	1.00	1.00	1.00	1.00
Ti	0.20	0.50	0.00	0.00
P	0.10	0.10	0.10	0.10
B	0.25	1.00	0.01	0.05
Pb	0.25	1.00	TR	TR
Ba	0.20	0.20	0.10	0.20

TR = Less than 0.01

M = Major constituent

Underlined values = greater than 1.00 %

All values below 1% have a precision of ± 50% from reported value and all above 1.00% are reported as either greater than 1% (underlined) or M (major constituent).

ter's descriptions of their specimens. The Quetta sample described as red lead (Pb_3O_4), and the Multan sample described as borax ($Na_2B_4O_7 \cdot 10H_2O$), were confirmed as such.

The four samples from Multan, semiquantitative analyses of which are tabulated in Table 10, showed complex compositions. The cullet (USNM 417,201) composition does not accord to a modern bottle or window glass composition, but is probably a locally produced glass made from impure raw materials. The powdered glaze (USNM 417,202) analysis may be compared with the quantitative analyses discussed here. Significantly, the analysis of the powdered glaze shows a boron content of greater than one percent. The quartzite (USNM 417,197-A) consists essentially of Si, Al, Ca, K (with oxygen) minerals. Inspection of broken quartzite pebbles showed that mica is present so it is likely that most of the Al and K is present in the form of micas. The plant ash (USNM 417,203) consists essentially of Si, Al, Mg, Ca, Na, and K. Oxygen, C, Cl, and S were not sought in the analysis.

Unfortunately quantitative analyses are not available at the time of writing. The plant ash analysis may be compared with analyses published by Brill (1970:126) analyses 1301, 1304, 1305, and particularly 1331. The latter is a sintered plant ash that Brill collected in Herat, Afghanistan, from a glass factory. These analyses show compositions in the approximate range: Na_2O, 35 to 40 percent; K_2O, 4 to 10 percent; CaO, 3 to 7 percent; MgO, 4 to 11 percent; and Al_2O_3, 0.4 to 1.8 percent.

Compositions in the analyses published by Brill (1970:126) are expressed as oxides although compounds in the ash are most likely carbonates, sulphates, and chlorides. Silica in the analyses published by Brill was very low, of the order 0.1 to 2 percent, but Brill noted that these values were suspect. Further analytical studies are desirable to clarify the composition of the Multan glaze materials, especially the raw materials plant ash and quartzite.

Heating and Fusion Experiments with Glaze Materials

Fusion Tests with Multan Glaze Materials.—Samples of glaze materials collected in Multan were used to investigate two questions: First, how reliable is the outline of glaze preparation techniques given by Multan potters during the field studies? Second, what is the fusion behavior of Multan frits and glazes? It was also considered desirable to obtain an estimate of the temperatures involved in the preparation of Multan frits and glazes.

Five separate samples of materials were tested: (1) USNM 417,203, sintered plant ash, ground to a powder by Multan potter for use in glazes, but not heated or mixed with any other materials in Multan; (2) USNM 417,204, a ball of mixed quartzite (50 percent) and sintered plant ash (50 percent), dried but unfired, prepared by Multan potters; (3) a mixture of sintered plant ash (USNM 417,590), 50 percent, and quartzite (USNM 417,591) 50 percent; both collected in Multan; (4) a mixture of borax (USNM 417,196), 5.88 percent (1 part), and crushed (powdered) fused balls of plant ash/quartzite mixture (USNM 417,199) 94.12 percent (16 parts); both collected in Multan; and (5) USNM 417,202, glaze ready for application to vessels, crushed final frit prepared by the Multan potter.

The reasons for selecting these specific materials or mixtures for fusion tests are as follows. It had been noted in the report of field studies in Multan, that the Multan glaze is prepared by three stages: first, the mixing of raw materials of plant ash and quartzite; second, the fusion of these two materials at an unspecified low temperature; and third, the crushing of the frit formed by this first fusion, the blending of other fusible ingredients if necessary, and then the fusion to form a final frit. This final frit, when crushed to powder, is used as the glaze for application to unfired vessels.

Sample 1, the plant ash, allows a check on the fusion of this raw material. Samples 2 and 3 are, respectively, a Multan potters mixture of raw glaze materials before the first fusion, and a laboratory mixture that should be identical in composition as well as particle size grading since the raw materials were ground by a Multan potter. These two samples allow both an estimate of the temperature of first fusion, and a check that the proportions of materials reported for the mixture by a Multan potter are correct.

Samples 4 and 5 are, respectively, a mixture reported by a Multan potter for the final frit, and a powder said by the potter to be the crushed frit. This allows another check of the potter's description of frit compositions and also an estimate of the temperature of the second and final fritting.

Each sample was divided into subsamples, each of about 5 g of powder, which was placed in a crucible. Separate subsamples of each of the five were heated in an electric kiln to temperatures between 600° and 1150°C (heating rate 170°C per hour). After slow cooling the crucibles were removed and the following observations made.

The results of the fusion tests are as follows:

Sample 1: The plant ash powder had sintered at

lower temperatures of 600°–700°C; fusion commenced between 800°–900°C. A frothy fusion, with many unreacted inclusions, had formed after heating to 1000°C.

Samples 2 and 3: If any fusible materials not noted during field studies had been added to sample 2, then sample 2 could have been expected to be more fusible than Sample 3, for which it was known that no other material had been added. In fact, the opposite was true; sample 3 was slightly more fusible than sample 2. Both mixtures had sintered between 600° and 750°C. Sample 3 began to fuse between 800° and 900°C and had formed a frothy frit after heating to 1000°C. Sample 2 only fused extensively after heating to 1000°–1100°C; at the latter temperature a frothy frit, with many unreacted inclusions, had formed. At this temperature, however, sample 3 appeared the more fusible; it had formed a transparent, white frit with fewer unreacted inclusions than sample 2 at 1100°C.

The appearance of samples 2 and 3 lead to the following conclusions: (1) The description of techniques given in field studies is correct, and no unmentioned fusible materials were added to the mixture for the first fusion, that is the mixture used to form balls that were thrown into the firebox of the kiln (Plate 74*d,e* shows fused balls from the first fusion). (2) By comparison of fused samples 2 and 3, with balls fused in Multan (USNM 417,199), it is judged that the balls from Multan had been fused at a temperature of about 900°C.

Samples 4 and 5: The fusion of these two samples was surprisingly alike. Sample 4 (first fusion and borax mix) sintered at 600°C, and extensive fusion was evident by 900°C, although many unreacted inclusions were still present. After heating to 1100°C, a relatively homogeneous glass with very few inclusions was formed. Sample 5 or Multan frit, as could be expected, began fusion as low as 700°C, and by 1000°–1100°C had formed a homogeneous glass, with no inclusions.

Material in the crucibles was dark colored at all temperatures, an unexpected phenomenon considering that the frit in Multan is a clear, transparent glass. The crucibles were heated in a kiln along with various other materials, some of which contained carbon and others sulphur in appreciable quantities. Apparently the carbon and sulfur emanating from other materials became incorporated in the pores of the two materials in the crucibles at low temperatures, and were sealed in by the fusion at still lower temperatures. In other samples that fused at higher temperatures, the carbon and sulfur were removed by oxidation before extensive fusion began. This experience indicates that the Multan potters, in preparing their frit, probably allow a soaking or at least slow heating at temperatures around 500°–600°C in order to burn out or oxidize any carbon present in the pores of the frit batch.

It is concluded from the appearance of samples 4 and 5 after heating to various temperatures, that the maximum temperature used by Multan potters to fuse the final frit, which is then crushed and used as glaze, is in the temperature range 1000°–1100°C.

Conclusions from fusion tests are as follows:

1. The outline of techniques used in preparation of frits, and ultimately the glaze, given by the Multan potters in the field and reported herein, is reliable.

2. The description of preparation processes may be refined by giving estimates of temperature: First, sintered plant ash and quartzite, both powdered, are mixed in equal proportions by weight. The mixture is formed into balls about 10 cm in diameter. When dry these balls are heated in the firebox of a kiln, to a temperature of about 900°C. The balls are then crushed to powder. At this stage, but not before, other fusible materials in powder form (borax, ground glass, others?) may be added to the batch. The powders are mixed, placed in crucibles, and heated in the kiln; heating is slow between 0°–600°C so that carbon and sulfur are completely oxidized. The fritting temperature is in the range 1000°–1100°C. This frit is later removed from the crucibles, crushed to powder, and without further compositional modification applied to vessels as the glaze (over a siliceous slip, with decoration).

3. The first fusion apart from giving a degree of homogeneity to the basic glaze material mixture of plant ash and quartzite, gives an empirical indication of the degree of fusibility of the specific batch, probably necessary because of compositional variations in the raw materials. The potter can then decide whether or not to add further fusible materials.

4. The second fusion on fritting gives a homogeneous glaze batch, which is either insoluble or only slightly soluble in water, compared with the alternative method of glaze preparation, which would be to simply combine all the raw materials and grind very finely and mix thoroughly to give a homogeneous batch. Both plant ash and borax, two commonly used glaze materials, are water soluble.

MATURING BEHAVIOR OF MULTAN GLAZE.—In order to study the maturing behavior of the Multan glaze, and to obtain an estimate of the maturing temperature, and hence the firing temperature of the ware, glazed briquettes made from Multan materials were fired under known laboratory conditions and then compared with glazes on vessels fired in Multan.

A body composed of 80 percent clay (USNM 417,205) and 20 percent sand (USNM 417,195) by weight, was made up. From this, small briquettes, each about 8×3×1 cm, were formed. These plastic-formed briquettes were allowed to completely dry. They were then given a coating of siliceous slip (USNM 417,198), which was a sample of prepared slip supplied by Bhuda Baksh of Multan. For application, the powdered slip was mixed with water containing a little gum arabic. The briquettes were coated on one face by dipping only that face, leaving the rest of the briquette uncoated.

When the slip coating had completely dried, glaze was applied over the slip. The glaze was powdered material, prepared for application, as with the slip, by mixing with water containing a little gum arabic. The original sample of powdered glaze (USNM 417,-202) was also supplied by Khuda Baksh of Multan. The coatings of both slip and glaze were applied at the same thickness as used on Multan ware.

The briquettes were fired in an electric kiln in an oxidizing atmosphere to temperatures between 520°–1100°C, at a hearing rate of 170°C per hour. The appearance of the fired test pieces at various temperatures was as follows:

520°C: The slip and glaze coatings were still friable, and appeared unaffected by the firing. No sintering had occurred.

600°C: The glaze had begun to sinter but the coating was still friable and easily detached as poorly bonded platelets.

730°C: The glaze had fused to the slip, but there was no bonding at all between the slip and body. The glaze and slip could be lifted from the body in one piece.

810°C: Glaze was further fused with slip, both could be detached from the body in one piece; still no adhesion between slip and body. The glaze was fused but obviously underfired.

900°C: The glaze had fused extensively but was still underfired. Glaze and slip adhered to body but could still be detached relatively easily. The glaze was extensively pinholed, and at this temperature had not developed sufficient fluidity to heal over the imperfections. Comparison with well-fired Multan vessels showed that they had all been higher-fired than these test-pieces.

1000°C: The glaze appeared to be fired within the normal range of matured glazes on Multan vessels. Glaze and slip were completely bonded together, could still be detached from the body but with difficulty by digging it off with a steel blade; the bonding was poorest where the glaze coating was thickest. The glaze was becoming clear and transparent, but some pinholing was still present. Comparison with Multan vessels indicated that the experimental pieces were underfired but were within the range of lower-fired, that is underfired in the original firing, Multan vessels.

1100°C: The glaze and slip were completely fused together and to the body. Glaze could not be detached from the body without breaking away portions of the body itself. No pinholing present; surface glaze imperfections had healed completely. The glaze was clear, transparent; crazing similar to that on well-fired vessels from Multan was noted. Compared with vessels fired in Multan, the glaze appeared properly matured to slightly overfired.

The above observations were initial impressions gained from simple examination of the test briquettes. In order to confirm the initial observations, the test pieces, and glaze coatings on vessels from Multan, were studied microscopically. A binocular microscope of ×80 magnification was used with a low, oblique lighting source, which eliminated reflections from the surface of the glaze and allowed study of the glaze-slip and slip-body interfaces.

For comparison the glaze on several vessels collected in Multan was also examined. Also, a set of six similar tiles (USNM 417,187-A–F), which had all been fired in Multan as a set of identical pieces were included. One of these tiles was refired in an electric kiln with an oxidizing atmosphere to 1000°C; another was fired to 1250°C.

Observations with the binocular microscope were as follows: the glaze surface of normally fired pieces from Multan was clear, transparent glass; all pieces showed extensive crazing. Extensive bubble formation was associated with the siliceous slip layer underneath the quartz grains and bubbles reflected all light so that the body surface underneath could not be seen at any incident lighting angle.

Normally fired tiles from the set of six showed a very shallow glass layer at the surface; the glass appeared slightly cloudy due to light dispersion by fine bubbles in the glass.

A tile refired at 1000°C had slightly more extensive bubble formation in the glaze layer than unrefired tiles; the bubbles appeared slightly larger, but the overall appearance was similar to the unrefired tiles. It was noted that areas of the tile where cobalt blue brushwork had been applied had wrinkled slightly at the surface.

A tile refired at 1250°C showed very extensive reaction of the thin glaze layer with the slip layer. The surface of the glaze was uneven, and followed localized variations in the thickness of the slip layer underneath, compared with normally fired Multan pieces,

and other test-pieces fired at lower temperatures, where the glaze surface was flat and even. There was extensive devitrification at the surface of the glaze, forming a very thin layer of crystals, which gave the refired tile glaze a matt appearance.

An experimental briquette fired at 1000°C appeared similar in the glaze and slip layers to Multan-fired vessels. The extensive bubble formation at this temperature was associated with the slip layer. Where the slip was thin, there were few bubbles, only about 5 per sq mm, compared to about 100 for Multan fired glazes. The glass layer was slightly cloudy, like that on the tiles (USNM 417,188) fired in Multan.

Another briquette, fired to 1100°C, had a layer of completely clear glass at the surface; quartz grains in the slip layer were all rounded, indicating extensive dissolution of silica in the glaze. Bubble formation was more extensive than at 1000°C; the greatest concentration of fine bubbles was at the body surface in areas where the slip layer was very thin; there was extensive formation of larger bubbles associated with the slip layer where it was thicker. There was some devitrification on the surface of the glaze around the edges of the briquette.

The glass layer on a briquette fired to 1250°C was very clear and transparent, but the surface showed extensive devitrification above areas where the slip layer was thickest, that is, where there was the greatest quartz concentration. The quartz grains in the slip layer were almost spherical and much reduced in diameter compared to those in lower fired test-pieces, indicating very extensive dissolution of the quartz in the glaze. Many bubbles were still present in the slip layer, and they were larger than those seen in any glaze on vessels originally fired in Multan.

CONCLUSIONS FROM FIRING EXPERIMENTS WITH MULTAN WARES.—The following four conclusions may be stated:

1. The samples of slip and glaze materials supplied by Khuda Baksh are representative of materials normally used in his workshop.

2. Firing tests with these materials indicate that the firing temperatures used for glazed ware in Khuda Baksh's workshop range between 950° and 1050°C; well-fired ware with a properly matured glaze are fired near the upper end of this range.

3. Comparison of experimental glazed briquettes formed from Multan materials and fired under controlled conditions, with vessels originally fired in Multan, was made by study of the glaze/slip/body with a binocular microscope. Observations agreed with the above conclusion that the Multan-fired vessels had been fired in the range 950° to 1050°C, or possibly as high as 1100°C.

4. Because of differences in firing atmosphere between the experimental firings using an oxidizing atmosphere throughout and the original firings in Multan where the atmosphere was probably fluctuating between mildly reducing and mildly oxidizing conditions, a more precise firing range for Multan ware cannot be specified. It is probable that the maximum suggested range of 950–1100°C would be reached in any one kiln in any one firing due to varying atmosphere and uneven heating conditions in the Multan kilns.

HEATING EXPERIMENTS WITH ZAKHEL BALA MATERIALS.—To obtain indications of the temperature of firing for Zakhel Bala lead-glazed ware, vessels from this area were reheated under known conditions in an electric kiln with a rate of temperature rise of 170°C per hour and then allowed to cool slowly.

A bowl (USNM 417,308-C) with red body, white slip brushwork decoration, and clear lead glaze was reheated to 1100°C. Before reheating, the glaze appeared normally matured. After reheating, the glaze had a very brilliant overfired appearance, and had reacted much more extensively with the body and slip. When tapped the bowl had a high ringing sound indicating more extensive vitrification than before reheating. The evidence suggests that the initial firing temperature was lower than 1100°C.

An interesting vessel was collected from Roshan Din, the potter whose work is discussed on pages 81–83. This hookah (USNM 417,313; Plate 82*b*) was unevenly overfired, so that one side appeared slightly overfired, but the other was greatly overfired and the body was severely bloated. In addition, the most severely overfired side had been reduced, and the normally green, copper-lead glaze had finished a bright red color. Analyses of glaze samples from this vessel were made.

The average apparent porosity of several pieces removed from the vessel was 4 percent. Briquettes made from body duplicating that used at Zakhel Bala were fired at temperatures between 800° and 1100°C; the apparent porosity of these varied from 28 percent to 22 percent, decreasing with temperature increase. The apparent porosity of another briquette fired to 1250°C was near zero. Extrapolating from an approximate apparent porosity vs temperature curve derived from these results, the overfired vessel originally reached temperatures between 1100° and 1200°C, where the combination of Ca-Fe in the body and reducing conditions, evidenced by dark body color and red glaze, caused the extensive vitrification.

No precise estimates of firing temperature of Zakhel Bala ware can be made from these simple experi-

ments, but it is suggested that the ware is normally fired to a maximum temperature between 950° and 1050°C.

Electron Microprobe Analyses of Fired Glazes

During the course of the studies reported here it became possible to use an electron microprobe for compositional studies of the Pakistan materials. Although this equipment has not previously been used extensively for analysis of fired glazes on vessels, it was decided to conduct a series of such analyses, both to study the composition of fired glazes and to evaluate the technique in this type of study. Methods used, and discussion of the technique and derivation of analytical values, are discussed in Appendix 4.

In order to study the composition of glazes on recently made vessels from Pakistan, samples were removed from vessels in the Ethnology collections of the Smithsonian Institution. A description of each vessel is included in the catalog in Appendix 1. Some samples of frit and of powdered glaze prepared for application to vessels were also studied. Samples were taken from:

Quetta (Baluchistan): USNM 414,542, urn with brown slip, green glaze (Plate 54*b*). USNM 414,547, hokah base, with brown slip and dark brown glaze (Plate 54*a*).

Zakhel Bala (NWFP): USNM 412,466, bowl, unglazed on the exterior, blue and brown brushwork decoration over white slip, and clear glaze on interior (Plate 68*b*). USNM 417,313, hookah base with white slip, green glaze, overfired with red glaze on one side (Plate 82*b*).

Pabbi bazaar (NWFP): USNM 417,308-D, bowl, unglazed on exterior, white slip and mottled green glaze on interior (Plate 68*e*).

Multan (Panjab): USNM 410,665-E, frit, greenish white glass, to be crushed and applied as glaze on Multan ware. Produced by second firing of glaze ingredients, in a crucible. USNM 417,190, large dish with white siliceous slip, blue, turquoise, and white brushwork decoration, clear glaze (Plate 75*a*). USNM 417,193-B, dish, with white siliceous slip, blue and turquoise brushwork decoration, clear glaze. The glaze is underfired. USNM 417,202, glaze (*kac*), powdered, ready for application to vessels before firing. Supposed to be crushed frit with no further additives.

Hala (Sind): USNM 410,486, frit, greenish white glass, still in crucible; to be crushed and applied as glaze. USNM 410,492, perforated tile, with white siliceous slip, blue brushwork decoration, turquoise glaze (Plate 77*d*). USNM 417,113-A & B, dish (A) with lid (B), white slip, brushed pink and brown slip decoration, amber glaze (Plate 78*d,e,f*). USNM 417,-124, tile, white siliceous slip, blue and green brushwork decoration, clear glaze; made in 1927.

The method of obtaining samples is outlined in Appendix 4. Several samples were removed from each of the vessels or frit specimens just listed and are also listed in Table 12 and 13. Specific samples were from the following:

Quetta (Baluchistan): USNM 414,542, sample 20, from area near base of vessel; sample 22, from neck of vessel, area containing blue inclusion. USNM 414,547, sample 23, from glaze flow on rim, suggesting the vessel was fired upside down; sample 25, from widest point of vessel.

Zakhel Bala: USNM 412,466, sample 5, from upper interior surface near rim. USNM 417,308-B, sample 9, from thickly glazed area on central interior. USNM 417,313, sample, from green area on correctly fired side of vessel; sample 16, from red area on overfired side of vessel; sample 16, from red area on overfired side of vessel.

Multan: USNM 410,665-E, sample 6, small piece broken from block of frit. USNM 417,190, sample 3, from white, undecorated area, interior; sample 18, from area on back, exterior, of dish, where the glaze has been applied directly on body (no slip); sample 24, from area with turquoise underglaze decoration, interior; and sample 26, from area with blue underglaze decoration, near rim. USNM 417,193-B, sample 2, from area with turquoise decoration underglaze on interior (upper) surface; sample 19, from area with blue underglaze decoration, upper surface; sample 27, from white, undecorated area, upper surface. USNM 417,202, samples 40, 42, 43, grains of powdered glaze prepared for use.

Hala: USNM 410,486, sample 7, small piece broken from block of frit near top of crucible; and sample 8, small piece broken from block of frit near base of crucible. USNM 410,492, sample 1, from light blue, turquoise, glazed area, on face of tile; and sample 4, from area with blue underglaze decoration on face of tile. USNM 417,113-B, sample 10, from area without painted slip, i.e., background area, with white slip under the glaze; sample 14, from area with dark brown slip under glaze decoration; and sample 15, from area with light brown to pinkish slip underglaze decoration. USNM 417,124, sample 11, from area with blue underglaze decoration on face of tile; sample 12, from area with green underglaze decoration on face of tile; and sample 17, from white undecorated area on face of tile.

Analytical values obtained by methods outlined in

Appendix 4 are summarized in Table 12, where the compositions of glaze samples are expressed as oxides of the elements analyzed. For most samples 15 elements were analyzed, which include the major colorants.

Data from Table 12 have been recalculated by conventional methods and expressed as molecular equivalents of oxides (Seger's formula); these values are in Table 13. Colorants have been omitted from this calculation, although SnO_2 (an opacifier or "colorant" has been included). Calculations for Table 13 have been made on the basis of sum flux group of oxides (MgO, CaO, Na_2O, K_2O, PbO) equals one. No other fluxes showed up in microprobe scans of samples so the relative data in Table 13 are not changed through finding additional elements in other groups by further analysis.

From data in Table 13, average compositions for glaze types from the different localities where samples were collected in Pakistan have been calculated. These average compositions, expressed as molecular equivalents of oxides, are given in Table 14.

Zakhel Bala and Pabbi Lead Glazes.—Four analyses have been made, two of normally fired glazes (sample 5 from Zakhel Bala and sample 9 from Pabbi), and two from an overfired vessel (samples 13 and 16, Zakhel Bala).

Within the precision limits of the analytical method, the slightly high summations of samples 5 and 9 of 102.6 percent and 102.9 percent, respectively (Table 12), are acceptable; most of the error may be present in the reported PbO values.

Samples 5 and 9 are similar to one another, especially when recalculated as molecular equivalents (Table 13). The Pabbi glaze sample 9, has slightly more SiO_2, higher Na_2O, K_2O, and CaO values and lower PbO, than the Zakhel Bala glaze sample 5.

As expected from the appearance of the glazes, sample 5 of a clear glaze shows (Table 12) a low content of coloring oxides (FeO, MnO, CoO, Cr_2O_3, and CuO). Sample 9 shows that the green color of this glaze was due to the presence of copper of about 2.5 percent CuO. The relatively high content of tin (SnO_2), 1.1 percent, may have been introduced with both the copper oxide and lead oxide in the batch. It has been previously noted (see Table 9 for analysis of copper scale colorant, and accompanying discussion) that the source of copper for use as a colorant is copper scale, a black copper oxide produced by heating copper scrap metal from disused copper vessels. It is common practice in Pakistan to coat the interior of copper vessels used for food preparation and consumption with tin. So part of the tin oxide in sample 9 may result from using oxides produced from tin-coated copper scrap.

No analyses of lead used in the frit batch are available. The potters prepared their own lead oxide by roasting mixed lead scrap, and it is quite reasonable to suggest that the metal contained small amounts of tin as an impurity. Because lead oxide additions to the frit batch were large, the tin content of the glaze could reasonably result in large part from this source.

A very important finding resulting from the analyses is that from the viewpoint of lead release, consistent use of vessels with such glazes for food storage and consumption, could result in lead poisoning. An indication of toxicity is given by the Mellor ratio (Lawrence, 1972:204). Calculation of the Mellor ratio for the Pabbi glaze shown in sample 9, gives a value of 0.69, which is above the acceptable safety limit of 0.5. The presence of a significant content of copper greatly increases the danger. The Mellor ratio for Zakhel Bala glaze is also above the acceptable safe limit.

How do the analyses of fired glazes relate to the compositions and procedures for glaze making described by the potters themselves (page 81)? A theoretical molecular composition of the fired glaze can be calculated from the raw batch composition, if pure materials are assumed for the calculation. Thus a composition of a glaze reported to Rye in 1971 by Roshan Din at Zakhel Bala, comprised of 12 parts weight of red lead (Pb_3O_4) equaling 80 percent and 3 parts by weight of sandstone (SiO_2) equaling 20 percent, gives a theoretical composition of molecular equivalents of $PbO = 1.00$ and $SiO_2 = 0.95$. A reported composition by R. Wulff in 1968 (Report 11, ATPR, 1967–1971) of 10 parts weight of red lead equaling 77 percent and 3 parts by weight of sandstone equaling 23 percent gives a theoretical composition of molecular equivalents of $PbO = 1.00$ and $SiO_2 = 1.14$.

Thus, taking into account that the flux groups in the analyzed glazes (samples 5 and 9) have 0.1 and 0.26 molecular equivalents, respectively, of oxides other than PbO, the SiO_2 content of both glazes is higher than anticipated by these calculations. In fact, to give the composition shown by samples 5 and 9 for silica, assuming all flux was Pb_2O_3 for the calculation, the initial composition of the batch would have to be about 70 percent red lead and 30 percent quartz sandstone.

It is suggested that two processes taking place as the glaze is fired cause a relative enrichment in silica in the fired glaze composition as compared to the initial batch composition.

The first is reaction with the slip (note that both

vessels have a white slip under the glaze) and possibly body layers, with quartz in the slip entering solution in the glaze. This is clearly evidenced by rounding of quartz grains in the slip zone adjacent to the glaze, as seen in microphotographs of the mounted thin-sections of glaze sample pieces.

The second is volatilization of lead from the glaze with temperature increase, which in terms of molecular ratios corresponds to silica enrichment. This has been discussed by Parmelee (1951), quoting the work of others. Drawing from the work of Anderson, he indicates (1951:111) that in PbO and SiO_2 mixtures with 85 percent PbO, loss of PbO can begin as low as 900°C; 60 percent PbO and 40 percent SiO_2 mixtures do not show loss until 1100°C. The surface should show greatest silica enrichment if lead is being lost through volatilization.

Without accurate data specifying firing temperatures for Zakhel Bala and Pabbi ware, it is not possible to estimate quantitatively the probable lead loss through volatilization. If, however, firing temperatures were near the top of the range of firing temperatures suggested of around 1050°C, volatilization of lead could significantly alter the glaze composition from that of the original batch.

The combination of these two processes of quartz dissolution from slip or body by the glaze, and the volatilization of lead from the glaze near maximum firing temperatures, can account for the difference between the molecular composition calculated from the potter's glaze batch composition and the molecular composition calculated from analyses of fired glazes. Therefore, it can be concluded that data provided by the potters on batch composition is reliable, certainly for the Zakhel Bala glaze.

The Pabbi glaze, said by the potters to be prepared in the same way as that of Zakhel Bala, has higher Na_2O, K_2O, and CaO, and lower PbO than the Zakhel Bala glaze (Table 13). CuO and SnO_2 content are also higher in the Pabbi glaze (Table 12). The copper would certainly have entered the batch as a distinct addition to give the glaze its green color. The reason for higher CaO, K_2O, and Na_2O values is not known, but there are two possible explanations. The first is that a small amount of glass cullet could have been added to the glaze batch, thus lowering the cost of the glaze, since cullet is a much less expensive material than lead frit. The second, more likely explanation is that the differences were caused by variations in composition of the siliceous or sandstone component of the glaze, and by variations in composition of the white slip with which the glazes had reacted.

Glaze samples 13 and 16 from an overfired Zakhel Bala vessel show dramatically lowered PbO content compared to samples 5 and 9. In sample 13, from the less strongly overfired side of the vessel, the PbO content is lowered to about one third of that in the normally fired glazes. On the more strongly overfired and also reduced side of the vessel the PbO content is about one twenty-fifth that of the normally fired glazes (Table 12). Roshan Din, the potter from Zakhel Bala who made and fired the vessel, said this vessel had the standard lead glaze applied; the only abnormality was the overfiring. So sample 13 and especially sample 16 provide clear evidence of the volatilization of lead at high temperatures. The evidence is that higher temperatures and reducing atmospheres increase the extent of volatilization.

TABLE 11.—*Ratios between values of molecular equivalents of oxides of samples 5, 9, 13, and 16 from Table 13*

MINERAL COMPOSITION	RATIOS OF SAMPLE			
	A (13:5)	B (13:9)	C (16:5)	D (16:9)
SiO_2....	1.90	1.90	3.00	3.00
Al_2O_3...	1.50	1.40	1.90	1.80
FeO	2.30	2.30	2.70	2.70
MgO	3.00	3.00	6.00	6.00
CaO	10.00	3.30	16.50	5.50
Na_2O ...	6.70	1.80	7.30	2.00
K_2O	8.50	2.80	11.00	3.70
TiO_2 ...	0.60	1.00	1.00	1.50
P_2O_5 ...	Z	Z	Z	Z
SnO_2 ...	10.00	2.50	20.00	5.00
PbO	0.40	0.50	0.05	0.07

Z= not calculated since molecular equivalent of the mineral composition of the particular sample was below 0.005.

Compared with samples 5 and 9, samples 13 and 16 show increased values for Al_2O_3, FeO, MgO, CaO, Na_2O, K_2O, SnO_2; the CaO increase is the most dramatic. Compared with sample 9 of a normally fired green glaze colored by Cu, the CuO values in samples 5, 13 and 16 are lower.

Using the molecular composition of the glazes given in Table 13, it can be shown that increased values for other "oxides" in samples 13 and 16 are not due simply to the removal of lead by volatilization. ¶If this were so then the content of each oxide in the high fired glazes would be directly correlated with content in the lower fired glazes. This correlation does not hold, as is indicated in Table 11, which gives ratios between values of molecular equivalents of oxides given in Table 13.

If the increasing content of all oxides were due to lead volatilization alone then each column would have the same value for all the oxides, except PbO, and there would be a strict correlation between all

TABLE 12.—*Electron microprobe analysis, expressed in percentage, of glaze samples from vessels recently collected in Pakistan* (sample numbers are below USNM catalog numbers)

MINERAL COMPOSITION	QUETTA				ZAKHEL BALA			PABBI	MULTAN						
	Fired green glaze USNM 414,542		Fired brown glaze USNM 414,547		Clear glaze USNM 412,466	Overfired glaze USNM 417,313		Lead glaze USNM 417,308	Clear alkaline glaze USNM 417,190				Underfired alkaline glaze USNM 417,193-B		
	20	22	23	25	5	13	16	9	3	18	24	26	2	19	27
SiO_2	57.50	56.60	56.80	56.00	30.7	49.9	65.00	32.8	70.20	64.00	61.30	63.20	62.90	65.20	64.00
Al_2O_3	2.33	2.18	1.66	1.72	4.3	5.4	5.80	4.6	2.65	3.04	1.98	2.35	1.94	2.31	2.14
FeO	0.83	0.63	0.44	0.52	0.7	1.4	1.32	0.8	0.53	0.95	0.54	0.50	0.65	0.60	0.80
MgO	1.03	0.66	0.47	0.54	0.3	1.0	1.64	0.4	1.84	1.39	1.84	1.70	2.67	2.43	2.50
CaO	9.50	7.80	6.00	6.20	0.4	3.0	4.20	1.1	6.20	5.00	6.20	6.00	6.40	6.00	6.00
Na_2O	6.20	7.40	10.40	8.70	0.6	3.4	3.11	2.3	10.30	12.00	8.50	8.60	9.00	9.00	9.60
K_2O	4.10	4.32	3.67	5.20	0.4	4.3	4.61	1.7	3.86	2.88	3.77	3.88	4.58	4.64	4.79
TiO_2	0.23	0.23	0.17	0.21	0.6	0.5	0.51	0.4	0.17	0.20	0.12	0.20	0.15	0.19	0.18
MnO	TR	TR	4.02	4.05	TR	ND	TR	ND	TR	TR	TR	TR	TR	TR	TR
P_2O_5	0.14	0.22	TR	TR	0.1	0.1	0.12	0.2	0.12	TR	0.25	0.14	0.17	0.13	0.17
CoO	ND	ND	ND	ND	TR	ND	TR	ND	TR	ND	ND	ND	TR	0.74	ND
Cr_2O_3	TR	TR	ND	ND	TR	ND	TR	ND	ND	ND	ND	ND	ND	ND	ND
SnO_2	0.50	ND	ND	TR	0.1	1.9	3.44	1.1	TR	ND	0.70	0.41	0.11	0.13	TR
CuO	4.38	4.87	1.58	1.29	0.1	2.2	2.01	2.5	0.15	ND	4.65	1.50	2.69	1.42	0.23
PbO	3.98	4.92	1.75	0.96	64.3	20.7	2.36	55.0	4.42	3.66	3.38	2.52	2.76	2.38	3.79
TOTAL	90.72	89.83	86.96	85.39	102.6	93.8	94.12	102.9	100.44	93.12	93.23	91.00	94.08	95.17	94.20

ND = element sought in analysis but not detected; NS = not sought in analysis; TR = present in trace amounts (below 0.1%).
Values have been rounded off to one decimal place for high (greater than 5%) lead glazes and all values above 5%. Other values are rounded off to two decimal places. See Appendix 4 for precision values.

TABLE 13.—*Composition of glazes from Pakistan, expressed as molecular equivalents of oxides* (calculated from data in Table 12; sample numbers are below USNM catalog numbers)

MINERAL COMPOSITION	QUETTA				ZAKHEL BALA			PABBI	MULTAN						
	Fired green glaze USNM 414,542		Fired brown glaze USNM 414,547		Clear glaze USNM 412,466	Overfired glaze USNM 417,313		Lead glaze USNM 417,113	Clear alkaline glaze USNM 417,190				Underfired alkaline glaze USNM 417,193-B		
	20	22	23	25	5	13	16	9	3	18	24	26	2	19	27
SiO_2	2.69	2.75	2.84	2.88	1.60	3.04	4.80	1.62	3.04	2.93	2.92	3.09	2.71	2.91	2.71
Al_2O_3	0.06	0.06	0.05	0.05	0.13	0.19	0.25	0.14	0.07	0.08	0.06	0.07	0.05	0.06	0.05
FeO	0.03	0.03	0.02	0.02	0.03	0.07	0.08	0.03	0.02	0.04	0.02	0.02	0.02	0.02	0.03
MgO	0.07	0.05	0.04	0.04	0.03	0.09	0.18	0.03	0.12	0.10	0.13	0.12	0.17	0.16	0.16
CaO	0.48	0.40	0.32	0.34	0.02	0.20	0.33	0.06	0.29	0.2[illegible]	0.32	0.32	0.29	0.29	0.27
Na_2O	0.28	0.35	0.50	0.44	0.03	0.20	0.22	0.11	0.43	0.53	0.39	0.41	0.38	0.39	0.40
K_2O	0.12	0.13	0.12	0.17	0.02	0.17	0.22	0.06	0.11	0.08	0.12	0.12	0.13	0.13	0.13
TiO_2	0.01	0.01	0.01	0.01	0.03	0.02	0.03	0.02	Z	0.01	Z	0.01	Z	0.01	0.01
P_2O_5	Z	Z	TR	TR	Z	Z	Z	Z	Z	Z	0.01	Z	Z	Z	Z
SnO_2	0.01	Z	TR	TR	Z	0.05	0.10	0.02	Z	Z	0.01	0.01	Z	Z	Z
PbO	0.05	0.07	0.02	0.01	0.90	0.34	0.05	0.74	0.05	0.05	0.04	0.03	0.03	0.03	0.04

Z = below 0.005 molecular equivalents; NS = not sought in analyses; TR = present only in trace amounts.

	HALA												
Frit	Glaze before firing			Lead glaze			Alkaline glaze		Alkaline glaze			Frit	
USNM 410,665-E	USNM 417,202			USNM 417,113			USNM 410,492		USNM 417,124			USNM 410,486	
6	40	42	43	10	14	15	1	4	11	12	17	7	8
64.10	59.30	64.60	55.20	29.3	27.0	27.8	70.30	68.20	69.40	56.3	73.40	69.90	70.00
2.28	2.42	2.83	3.85	2.2	1.6	1.4	1.73	1.70	4.13	4.3	2.52	0.86	0.66
0.67	0.65	0.61	1.27	0.8	3.3	1.0	0.78	1.22	0.87	0.9	0.73	0.35	0.27
1.95	3.83	3.53	4.43	0.4	0.4	0.4	0.42	0.17	0.45	0.5	0.33	0.13	TR
2.54	4.46	4.63	4.64	0.6	1.6	0.6	2.80	1.02	1.15	0.9	1.42	0.75	0.29
19.80	21.50	20.60	21.00	0.3	0.3	0.3	16.20	18.90	19.60	13.5	18.60	9.80	9.50
3.56	2.42	2.78	2.70	0.3	0.1	0.1	2.56	2.07	2.88	2.3	3.42	0.58	0.62
0.10	0.17	0.17	0.21	0.4	0.3	0.3	0.14	0.20	0.31	0.3	0.20	0.13	0.12
TR	NS	NS	NS	TR	0.2	TR	ND	TR	ND	ND	ND		ND
0.32	0.32	0.27	0.38	0.2	0.2	0.2	0.23	TR	TR	0.1	ND	ND	ND
ND	NS	NS	NS	0.1	0.1	0.4	ND	0.29	1.14	ND	ND	ND	ND
ND	NS	NS	NS	0.1	0.1	0.3	ND	TR	ND	0.2	ND	ND	ND
ND	NS	NS	NS	0.3	0.3	0.3	0.42	0.79	ND	ND	ND	ND	ND
ND	NS	NS	NS	0.5	1.8	0.7	4.54	4.03	ND	1.3	ND	ND	ND
ND	NS	NS	NS	68.0	68.6	71.3	0.39	0.60	0.20	16.1	0.20	ND	ND
95.32	100.32	100.02	93.68	103.5	105.9	105.1	100.51	99.19	100.13	96.7	100.82	82.50	81.46

	HALA												
Frit	Glaze before firing			Lead glaze			Alkaline glaze		Alkaline glaze			Frit	
USNM 410,665-E	USNM 417,202			USNM 417,133			USNM 410,492		USNM 417,124			USNM 410,486	
6	40	42	43	10	14	15	1	4	11	12	17	7	8
2.37	1.80	2.02	1.64	1.45	1.26	1.32	3.34	3.22	3.04	2.72	3.29	6.44	6.97
0.05	0.04	0.05	0.07	0.07	0.05	0.04	0.05	0.05	0.11	0.12	0.07	0.05	0.04
0.02	0.02	0.02	0.03	0.04	0.13	0.04	0.03	0.05	0.03	0.04	0.03	0.03	0.02
0.11	0.17	0.16	0.20	0.03	0.03	0.03	0.03	0.01	0.03	0.04	0.02	0.02	0.01
0.10	0.15	0.16	0.15	0.03	0.08	0.03	0.14	0.05	0.05	0.05	0.07	0.07	0.03
0.71	0.63	0.62	0.60	0.02	0.02	0.02	0.75	0.87	0.84	0.63	0.81	0.88	0.92
0.08	0.05	0.06	0.05	0.01	0.01	0.01	0.08	0.06	0.08	0.07	0.10	0.03	0.04
Z	Z	Z	Z	0.01	0.01	0.01	Z	0.01	0.01	0.01	0.01	0.01	0.01
Z	Z	Z	Z	0.01	0.01	Z	Z	Z	Z	Z	Z	Z	Z
Z	NS	NS	NS	0.01	0.01	0.01	0.01	0.01	Z	Z	Z	Z	Z
Z	NS	NS	NS	0.91	0.86	0.91	Z	0.01	Z	0.21	Z	Z	Z

columns. This is obviously not the case. The greatest increase in content is shown for CaO, Na_2O, and K_2O. These are the three components of the body or slip which, especially if reducing conditions are present, would begin vitrification at temperatures below that to which the vessel was fired, estimated to be at 1100°–1200°C. Mineralogical studies have shown (Tables 6, 8) that the original body contained, with other minerals, plagioclase, dolomite, and micas. MgO fuses rapidly at temperatures above that to which this vessel was subjected.

In summary, the analyses of the overfired glazes compared with normally fired glazes show a decrease in lead content due to increases in volatilization of Pb with temperature, and an increase of other oxides in amounts greater than can be accounted for by enrichment due to loss of PbO. Greatest increases are shown by CaO, K_2O, Na_2O. The increase is thus greatest for the oxides most significantly contributing to fusion in the body or slip at the temperatures to which the vessel was fired. Further detailed studies are required to determine whether the increases are consistent with an explanation based on Fick's Law (Parmelee, 1951:107), which governs rates of diffusion according to differences of concentration of elements.

The reason for low summation (Table 12) for samples 13 and 16 of 93.8 and 94.12 percent, respectively, is not clear. No further elements were detected in microprobe scans of the sample sections. The presence of boron is unlikely in sample 5 because of the low Na_2O content (Na_2O would be associated with B_2O_3 if borax had been added). Therefore, B_2O_3 should not be present in samples 13 and 16 which are analyses of a glaze made by the same potter, who himself made no mention of the use of borax. The summations are within the limits indicated by analytic precision values (Appendix 4).

Conclusions from the study of the Zakhel Bala and Pabbi glazes are as follows:

1. Analyses of Zakhel Bala glaze showed compositions consistent with the potter's outline of the glaze making process.

2. The glazes could be toxic if used for food storage or consumption for long periods.

3. The initial composition of the lead glazes is altered during firing; PbO is lost through volatilization, and the glaze becomes enriched in other constituents originating from elements that have formed glass in the body or slip at the temperatures involved.

4. Apart from differences in the specific samples due to addition of colorants, a Zakhel Bala glaze and a Pabbi glaze were essentially similar.

5. Further detailed experiments with controlled materials are necessary in order to study the kinetics of firing reactions between glaze, slip, and body as a function of temperature. This applies specifically to compositional changes as determined by electron microprobe analytical techniques.

Lead Glaze from Hala.—The potter Shafi Mahommed of Hala said in 1971 that two distinct types of glaze are used in his workshop: a lead glaze and alkaline glaze. The techniques of glaze making have been discussed. Several glazed vessels or tiles from Hala are included in the present analytical study. Only one of these samples was obtained from Shafi Mahommed, a tile (USNM 417,124), which was made in 1927 by the potter's father, who, according to Shafi Mahommed, used similar techniques and materials to those which he himself still uses. The vessel from which the lead glaze samples were taken, therefore, was not made by the Shafi Mahommed, who provided the compositional data; in fact this vessel was collected in 1971 by Rye as a purchase of a typical vessel from a Hala bazaar.

One aim of the analytical study of Hala wares was to determine whether glazes on vessels from other Hala workshops were compatible with the description of glaze making given by Shafi Mahommed, or whether a variety of compositions would be found.

Only one lead-glazed vessel from Hala was included in the analytical study (USNM 417,113, Plate 78*d,e,f*). Analyses of three fragments removed from this vessel were carried out (samples 10, 14, 15).

As with all other analyses, the values have been reported directly as calculated from probe counts, with appropriate correction factors applied, and not rounded off to give a 100 percent total. It will be noted in Table 12 that the totals for the three Hala lead glaze analyses vary from 103.5 percent for sample 10 to 105.9 percent for sample 14. Applying Nelen's precision limits for individual values (Appendix 4), the maximum range of errors in the totals would fall within the limits: sample 10, 103.5 ± 7.4 percent; sample 14, 105.9 ± 7.3 percent; and sample 15, 105.1 ± 7.2 percent.

Thus, in each case a true 100 percent total falls within the limits of accuracy of the reported totals in each analysis. Nelen has suggested that the greatest error is likely to be the reported value of PbO, for which the true value is likely to be lower than those reported in Table 12.

The analyses of USNM 417,113, designated as samples 10, 14, and 15 from the same object, when averaged together show that SiO_2 and PbO are the major constituents of the glaze; they are 28.03 and 69.3 percent, respectively. Further analysis of the

averaged values show that three constituents are present in concentration greater than 1 percent: FeO at 1.7 percent, Al_2O_3 at 1.73 percent, and CuO at 1.0 percent. CaO is just a fraction under 1 percent averaging 0.93 percent. The total content of the constituents other than these six adds up to only 2.3 percent.

The variations in SiO_2 and PbO are best examined from the molecular ratios given in Table 13. The PbO values, calculated from samples 10 and 15, are identical, that from sample 14 is slightly lower, and corresponds to an increased CaO value for that analysis. Sample 14 is that of a sample of glaze removed from the vessel over an area with dark brown slip underneath; compared with the other two samples it shows an increased content of FeO, CaO, and CuO (Table 12), suggesting the possibility that these three elements were introduced by the slip rather than the glaze itself, and are present in the glaze through solution from the slip at high temperatures. It must be remembered that the glaze would have been applied as a relatively homogeneous powder suspension; and it is very unlikely that variations in the glaze itself from one area of the vessel to another could be responsible for the difference in CaO content between samples 10 and 15 versus 14.

In the three analyses the FeO content varied from 3.3 to 0.8 percent (Table 12). A semiquantitative check of the slip composition, while the sample pieces were on the probe, showed that the Fe content of the slip layer varied similarly, according to the reasonable expectation that the FeO content of the white slip (sample 10) would be lowest, the light brown slip (sample 15) intermediate, and the dark brown slip (sample 14) highest. The presence of a significant CuO content was not expected in any of these analyses, but sample 14 shows 1.8 percent CuO in the glaze over dark brown slip, suggesting that the slip contained CuO as either a natural "impurity" or as an intentional addition by the potter. The use of copper oxide for a *green* slip was mentioned by Shafi Mahommed; but he made no reference to the intentional addition of copper oxides to the other slips. So it may be concluded that copper was present in the dark brown slip as a natural impurity, and in the analyzed glaze through reaction between the slip and glaze.

Returning to an examination of the PbO and SiO_2 content shown by the three analyses, it has been

TABLE 14.—*Composition range and average composition of Pakistan glazes, expressed as molecular equivalents* (average compositions are underlined and were derived from averaging values of all samples from Table 13)

MINERAL COMPOSITION	ZAKHEL BALA and PABBI	HALA		MULTAN		QUETTA
	Clear lead glazes	Lead glazes	Alkaline glaze	Unfired glaze	Fired glaze	Alkaline glaze
SiO_2.....	1.60 1.61 1.62	1.26 1.34 1.45	3.04 3.22 3.34	1.64 1.82 2.02	2.71 2.90 3.09	2.69 2.79 2.88
Al_2O_3....	0.13 0.14 0.14	0.04 0.05 0.07	0.05 0.07 0.11	0.04 0.05 0.07	0.05 0.06 0.08	0.05 0.06 0.06
FeO	0.03 0.03 0.03	0.04 0.07 0.13	0.03 0.04 0.05	0.02 0.02 0.03	0.02 0.03 0.04	0.02 0.03 0.03
MgO	0.03 0.03 0.03	0.03 0.03 0.03	0.01 0.02 0.03	0.16 0.18 0.20	0.10 0.14 0.17	0.04 0.05 0.07
CaO	0.02 0.04 0.06	0.03 0.05 0.08	0.05 0.08 0.14	0.15 0.15 0.16	0.24 0.28 0.32	0.32 0.38 0.48
Na_2O.....	0.03 0.07 0.11	0.02 0.02 0.02	0.75 0.82 0.87	0.60 0.62 0.63	0.38 0.42 0.53	0.28 0.39 0.50
K_2O	0.02 0.04 0.06	0.01 0.01 0.01	0.06 0.08 0.10	0.05 0.05 0.06	0.08 0.12 0.13	0.12 0.14 0.17
TiO_2	0.02 0.03 0.03	0.01 0.01 0.01	0.00 0.01 0.01	X	0.00 0.01 0.01	0.01 0.01 0.01
P_2O_5	X	0.00 0.01 0.01	X	X	0.00 0.00 0.01	X
SnO_2	0.00 0.01 0.02	0.01 0.01 0.01	0.00 0.01 0.01	NS	0.00 0.00 0.01	0.00 0.00 0.01
PbO	0.74 0.82 0.90	0.86 0.89 0.91	0.00 0.00 0.01	NS	0.03 0.04 0.05	0.01 0.04 0.07
B_2O_3	X	X	X	?	0.22 (?)	0.50 (?)
Calculated from samples	5, 9*	10, 14, 15	1, 4, 11, 17	40, 42, 43	2, 3, 18, 19, 24 26, 27	20, 22, 23, 25

* Samples 13 and 16 were omitted from this averaging because the composition was atypical from the overfired glaze.

NS = not sought in original analysis; X = less than 0.01 molecular equivalents average.

Note that all colorants except FeO have been omitted. B_2O_3 values have been calculated by taking the differences from the original analyses given in Table 12 i.e., 100% (analytical total) minus B_2O_3, and were not the result of analysis.

shown that variations in the PbO content, calculated as molecular equivalents could be due to localized reactions between the glaze coating and the slip layer underneath. The SiO_2 (Table 13) varied from 1.26 to 1.45 molecular equivalents; this may be considered a relatively minor variation. Again it is likely that the variation is due to reaction between the glaze coating and the slip layer; but a problem arises with this explanation.

Comparing the composition given by Shafi Mahommed for the lead glaze batch (1 parts red lead, 5 parts quartz sand) with the composition of the glaze shown by analysis, the analyzed glaze is silica deficient. If the molecular composition of a glaze consisting of 68.75 percent Pb_3O_4, and 31.25 percent SiO_2 (a theoretical composition based on Shafi Mahommed's glaze batch but calculated on the basis of "pure" SiO_2 and Pb_3O_4) is calculated, it shows a composition corresponding to $PbO = 1.00$, $SiO_2 = 1.73$. The actual silica content of the glaze (average of three analyses) is 1.34 molecular equivalents (Table 14).

This variation may be expressed in the following way: (1) Red lead 68.75 percent and quartz sand 31.25 percent, where this data is that stated by potter Shafi Mahommed for the glaze frit batch; and (2) red lead approximately 74 percent and quartz approximately 26 percent, where the data is obtained by the average composition of samples 10, 14, and 15 and it is assumed that the materials are pure. This reveals an inconsistency. If the glaze on the vessel reacted with the slip layer at high temperatures, then it should have a higher SiO_2 content (because of solution of SiO_2 from the slip in the molten glaze) than that calculated for that batch. That is, the analytic value for SiO_2 should be greater than 1.73 molecular equivalents. Instead, the analytical value is lower: 1.34 molecular equivalents.

Further adding to the inconsistency is the probable influence of the volatilization of Pb from the glaze, discussed previously in relation to Zakhel Bala lead glazes (p. 149). If, as could be expected, Pb had been removed from the glaze by volatilization, the SiO_2 value should again be higher than the calculated value. Combining these two compositional influences on the fired glaze, that is, solution of the silica from body or slip in the molten glaze and volatilization of lead from the molten glaze, it would be predicted that the molecular ratio SiO_2/PbO should be higher in the fired glaze (USNM 417,113) than in the batch composition given by Shafi Mahommed. Why, then, is it lower?

It can be deduced that the analyzed glaze, from a vessel bought in a Hala bazaar (USNM 417,113), was glazed with a composition different from the composition given and used by the potter Shafi Mahommed (USNM 417,124). An estimate of the batch composition of the analyzed glaze can be made from the following observations.

It is probable that the Hala glaze was fired to a lower temperature than the Zakhel Bala glazes; the analyses of the Hala glaze show a very low content of elements, which would be present if extensive reaction with slip or body had occurred. It can be assumed that with the lead content of the Hala glaze sample 10 of 29.3 percent that any firing over 950°–1000°C would cause volatilization of lead and corresponding enrichment in silica, albeit less than in the normally fired Zakhel Bala glaze.

Calculations on the basis of theoretically pure SiO_2 and Pb_2O_3 mixtures show that for the Zakhel Bala glaze, a shift in composition occurs during firing which corresponds to a change of about 7–10 percent decrease in Pb_3O_4 in a theoretical SiO_2-Pb_3O_4 mix. Assuming that this composition shift is less for the analyzed Hala lead glaze, it can be estimated at 1 to 5 percent. So the batch composition of the analyzed glaze would have been in the range of red lead 75–80 percent, and quartz sand 20–25 percent. This means that the batch composition of the analyzed glaze was higher in Pb_2O_3 than the composition used by Shafi Mahommed of about 69 percent Pb_3O_4, 31 percent SiO_2, and it was probably similar to the composition used at Zakhel Bala.

Conclusions from the study of the Hala lead glazes are as follows:

1. Analyses of a Hala glaze showed that Hala potters may use lead glazes of slightly differing composition, based on red lead and quartz sand. The red lead addition to the glaze batch may vary between about 70 and 80 percent, the remainder is quartz sandstone.

2. The Hala lead-glazed ware is fired to a lower temperature than the lead-glaze ware of Zakhel Bala and Pabbi.

3. Analyses with electron microprobe may differentiate Hala, and Zakhel Bala and Pabbi lead-glazed wares on the basis of lower SiO_2, Al_2O_3, Na_2O, and K_2O, and higher PbO content. Analyses of a larger number of samples is necessary before this can be confirmed.

Alkaline Glaze from Hala.—Seven samples representing the Hala alkaline glazing technique were analyzed. The samples were obtained from three separate sources. USNM 410,492 was collected in 1968, as was USNM 410,486, a sample of frit prepared by a Hala potter. USNM 417,124 was purchased from Shafi Mahommed, who said that this tile was made in 1927 by his father. He also said the

glaze on that tile was identical to the alkaline glaze he was still using.

In comparison of the two glazes (USNM 410,492 and USNM 417,124) samples 1 and 12 should be considered as atypical (Table 12). The reason is that the sample piece of glaze (sample 12) was removed from an area of the tile which had green brushwork decoration underneath the glaze. Sample 12 shows that the green pigment contained copper as the colorant, and lead as a color modifier. Copper gives deep colors in a lead-based glaze; in an alkaline (Na-K) based glaze the color tends towards turquoise blue, as is the case with the glaze on USNM 410,492 (samples 1 and 4) where the turquoise color is due to the presence of copper in the alkaline glaze.

The glaze sample represented by sample 12 had become Pb-enriched through reaction with the green pigment; consequently, the content of other elements, except MgO and FeO was lower than for other samples of glaze from the same tile.

Samples 1 and 4 show that the glaze on USNM 410,492 was colored by copper. The tin and lead content of this glaze was probably introduced as impurities with the copper oxide.

Other than this, both glazes on USNM 410,492 and USNM 417,124 were essentially very similar. This is best seen in Table 12. The glazes consisted of essentially SiO_2 (average about 70 percent) and Na_2O (average about 18 percent), the remainder Al_2O_3, MgO, CaO, and K_2O. Considering that the siliceous slip used under the glaze was ground flint, it is probable that these latter four oxides were introduced in the original batch rather than through reaction between molten glaze and slip at high temperature.

The similarity of these glazes suggests that alkaline glazing techniques in Hala have changed little in the period from 1927 to 1967, especially considering that the two samples were from different workshops. Further analyses of a larger number of samples could confirm this.

How do the glaze analyses compare with the batch composition given by Shafi Mahommed? Unfortunately, no samples of soda ash were collected during field work, and Shafi Mahommed was not asked whether the batch composition was based on hydrated soda ash ($Na_2CO_3 \cdot 10H_2O$) or on fused soda ash (Na_2CO_3), in which the water had been driven off by heating the hydrated ash. It has been noted that the flint used for the siliceous slip is calcined. So calculations of a theoretical fired glaze composition of molecular equivalents, have been made on the basis of both fused and hydrated soda ash (50 percent), with quartz (50 percent) as the batch composition. These show that the theoretical composition in molecular equivalents of 50 percent hydrated soda ash and 50 percent SiO_2 is $SiO_2=4.76$ and $Na_2O=1$; and the theoretical composition of molecular equivalents of 50 percent fused soda ash and 50 percent SiO_2 is $SiO_2=1.76$ and $Na_2O=1$. The latter mixture falls very close to a eutectic in the Na_2-SiO_2 system (SiO_2 62 percent, Na_2O 38 percent fusing at 830°C). The lowest melting mixture in this system is SiO_2 75 percent, Na_2O 25 percent, fusing at 780°C.

It can be assumed that when the glaze was fired it would become silica-enriched through reaction with the siliceous slip, although the extent of silica enrichment cannot be predicted quantitatively. So the first possibility, that the glaze batch was composed of 50 percent hydrated soda ash and 50 percent quartz sand, is unlikely. Such a mixture already contains more silica than the fired glaze. If in fact hydrated soda ash was used, to give the average composition (Table 14) of Hala alkaline glazes, the initial batch composition before fritting can be calculated as about 60 percent soda ash and 40 percent silica on the basis of pure materials.

Conversely, the calculations made for fused soda ash give a composition which appears silica deficient ($SiO_2=1.76$ molecular equivalents, $Na_2O=1$) compared to the values obtained by analysis. To give the average analyzed value, a batch composition of about 36 percent fused soda ash and 64 percent silica would be required.

Thus the field data, which indicates a batch composition of 50 percent soda ash and 50 percent quartz sand, is thrown in doubt. Samples 7 and 8 of a Hala frit further confuse rather than clarify the problem. The average frit composition matches the average Hala alkaline glaze composition well, except for one major variation. The SiO_2 content of the frit is much higher (6.71 molecular equivalents) than that of the alkaline glaze average (3.22 molecular equivalents). Both frit and alkaline glaze average values for Na_2O are very high (0.90 and 0.82 molecular equivalents, respectively), which serves to distinguish both from any of the other average compositions in Table 14. Because, however, of the reasonable expectation that the fired glaze should be richer in silica than the frit, because of reaction with slip and body during firing, this frit (samples 7 and 8) could not have been used to produce the fired glaze compositions.

The collectors of these 1968 samples did not indicate in their catalog whether or not the frit (USNM 410,486) was collected from the same potter as the perforated tile (USNM 410,492). Therefore, the inconsistencies must remain unresolved until further field work is completed, and samples of initial batch

materials analyzed. These inconsistencies may be due to calculations on "pure" materials; it is unlikely that the glaze materials, particularly sand, would not contain other elements in significant amounts.

One further problem with the frit remains to be discussed. Summations for samples 7 and 8 of the Hala frit average close to 82 percent, well below a value which could be considered, within precision limits, to be satisfactory. Scans of the samples with the probe showed trace amounts of Cl and S, but no elements were detected other than those indicated in Table 12. The only element which could conceivably be present, but undetected with our analytical facilities, was boron.

If the difference between 100 percent and the analytical summations of samples 7 and 8 is considered to be boron, a batch composition which would correspond to the Na_2O-B_2O_3-SiO_2 values of samples 7 and 8 can be calculated. The result is that a mixture of 50 percent of fused, anhydrous, borax ($Na_2B_4O_7$) and 50 percent quartz sand fits very closely to the analytical values plus the assumed B_2O_3; that is, about 18 percent B_2O_3, 8 percent Na_2O, and 74 percent SiO_2.

This speculation is not unjustified, for three reasons. First, the frit of samples 7 and 8 has not been directly linked to the glazes from Hala that have been analyzed in the study and gave good summations and in which there is no reason to suspect the presence of boron. Second, although not very strong evidence, the frit composition could be produced simply by exchanging the soda ash in Shafi Mahommed's formula (50 percent soda ash, 50 percent quartz sand) for fused borax. The third and strongest evidence is provided by the unpublished field notes made in Hala in 1967 by Hans Wulff. He has referred to data given to him by a Hala tile maker. His notes do not give quantitative compositions or differentiate between lead and alkaline glazes, but state that the potter used the following glaze materials: "quartz sand, red lead, locally-produced soda ash, and borax" (Wulff, 1967 notes). The borax is described as a "white glass" by Wulff, suggesting that the Hala tile maker may have been using fused borax (that is, borax heated to 700°–800°C to remove the hydrated water, giving the composition $Na_2O \cdot 2B_2O_3$). Thus, there is evidence that borax may have been in use by Hala potters from whom the frit sample was collected. So, although the use of borax was not mentioned to Rye by Hala potters in 1971, Wulff noted its use in 1967.

The low analytical summations of frit samples 7 and 8, which cannot be explained in terms of analytical error or omission, except for boron, can be explained if the potters who made the frit used a mixture of 50 percent fused borax and 50 percent quartz sand. Further field and laboratory studies should eventually clarify the situation.

Despite several problems that have arisen with the analyses of two Hala glazes and one frit, some findings are valid. First, two glazes made and fired in Hala 40 years apart are very similar in composition, apart from added colorants. The Hala alkaline glazes can be distinguished analytically from all others in the present study by their high (average 0.82 molecular equivalents) Na_2O content. Partial analysis of a frit from Hala showed it to be similar to the fired Hala alkaline glazes, apart from its higher SiO_2 content.

Conclusions from study of Hala alkaline glazes are as follows:

1. Analyses of a turquoise blue glaze showed that the color was primarily due to the presence of copper of about an average of 4.3 percent. A small content of PbO and SnO_2 may have been added as impurities with the copper.

2. The sparingly used deep green pigment on Hala ware is based on a mixture of Cu, Pb, and Sn, the latter of which can be considered an impurity introduced with the Cu or Pb.

3. Analyses of two Hala alkaline glazes showed their compositions to be very similar, although one was fired in 1927 and another in 1967. This suggests that glazing techniques have been stable over this period.

4. Batch compositions indicated during field studies are suspect; further field work should clarify the discrepancies.

5. Analyses of a frit had low summations, suggestive of the presence of boron. The frit otherwise had a similar composition to glazes except for a higher SiO_2 content.

Analyses of Multan Frit and Glazes.—Several samples from Multan were included in the analytical studies: a sample of frit (sample 6); grains of powdered glaze, before application to unfired vessels (samples 40, 42, 43); and samples from two vessels (samples 3, 24, and 26 from USNM 417,190; samples 2, 19, and 27 from USNM 417,193–B). With the exception of the frit, all samples were collected from the same potter and, therefore, should be comparable. For further comparison a complete collection of glazing materials was made from the same potter, Khuda Baksh in 1971 (Appendix 1), enabling further study of the Multan glazing process.

The frit (sample 6) consists essentially of silica and soda, 64.1 and 19.8 percent, respectively. The only colorant present in measurable quantity was 0.67 percent FeO. P_2O_5 was high compared to

samples of glaze from other areas at 0.32 percent. This was true in general of all the Multan glazes. By contrast, the TiO_2 content was lower than in glazes from other areas. The P_2O_5 content of the frit and unfired glaze was probably introduced in the plant ash on which these glazes are based.

Apart from Na_2O, the other fluxes were CaO, K_2O, and MgO; no lead was present in the frit (sample 6). It has been noted that there are two stages in preparation of Multan glazes: the initial sintering of plant ash and quartzite, followed by addition of other fluxes (borax, glass, etc.) and fusion to a final frit, which is crushed and used without further modification as the glaze. Sample 6 is thus a composition which would be finally crushed and applied as the glaze. Thus, the absence of lead is sufficient to show that it is distinct from the glazes made and used by Khuda Baksh.

Specifically, referring again to the frit, the analytical summation is 95.32 percent. Precision data (Appendix 4) indicate that the accuracy of this summation is ±3.06 percent. The true summation is between 92.26 and 98.38 percent; leaving between about 1.6 and 7.8 percent unaccounted for. It is known that borax is used in Multan, so the remainder could be boron, which could not be detected with our microprobe. The batch weight addition of hydrated borax would be between about 4.4 and 21.4 percent, or about half that if fused borax were used. The addition of borax suggested by Khuda Baksh of one part borax to 16 parts of sintered plant ash/quartzite, that is, 5.88 percent borax, falls within these limits.

The analysis of the frit (USNM 410,665-E) collected in 1967 is essentially similar to that of the 1971 Multan glazes, fired (USNM 417,190, USNM 417,193-B) and unfired (USNM 417,202), except for its lack of Pb and different SiO_2 and Na_2O content. Significantly, samples 6, 40, 42, and 43 have about 20 percent Na_2O, whereas the fired glazes have about 10 percent. An explanation reconciling this difference is that the sodium in the frit is still partially soluble in water, and that some of the soluble sodium is removed by solution when the glaze is suspended in water for application. It was noted that a block of the frit, left standing for long periods of 1–2 years had a thick layer of white, bitter-tasting saline efflorescence on the surface. This crystalline material is water soluble.

Samples 40, 42, and 43 of a glaze before firing (that is, crushed frit) were similar. In fact, more variation than this was anticipated; the frit is heated in previously unfired clay crucibles coated on the inside with a wash of quartz and clay, and some reaction with crucible and wash could be expected at the edges of the frit. This nonhomogeneity is overcome in the preparation of the glaze by crushing the frit to a very fine powder (about 150 μ and finer—USS 100 mesh sieve) and mixing thoroughly. Even so, individual grains of the crushed frit could be expected to vary in composition. Three grains, selected randomly, in this case had similar compostions.

It is interesting to compare samples 40, 42 and 43, and sample 6 with the composition range of plant ashes from Brill's analyses (1970:126). Brill's analyses show a Na_2O content ranging between 35 and 40 percent in the plant ash. The Multan frits have about 20–21 percent Na_2O, which is consistent with batch composition of 40–45 percent plant ash and 20–10 percent borax, with 40–45 percent quartzite, at least with respect to Na_2O.

Optical emission spectroscopy has shown that the unfired glaze powder represented by samples 40, 42, and 43 contains boron in quantities greater than one percent and that the quartzite contains only traces of Na. These analyses indicate that the quartzite, ground glass cullet and plant ash do not contain boron in sufficient amount to give a content greater than one percent in the glaze. This means that Khuda Baksh's assertion that borax is added to the second frit batch is definitely correct. It has been shown above that his suggested addition of about 6 percent borax to the second frit batch is confirmed within the limits of precision of the analyses for the 1967 frit (sample 6). Similarly it is true for the 1971 collected glaze (samples 40, 42, 43).

Unfortunately, samples 40, 42, and 43 were analyzed for nine elements only, and Pb was not sought. Because this frit was made by Khuda Baksh, who also made the vessels USNM 417,190 and USNM 417,-193-B it is probable that the frit contains Pb, considering that both glazes have about 2.5 to 4.5 percent PbO. Khuda Baksh did not mention the addition of lead during the discussion of glaze compositions. Of the batch ingredients that he did mention, the only one likely to contribute lead was the glass cullet; but analyses of this glass show only about 0.25 percent PbO, much less than could account for the PbO content of the two analyzed glazes: Therefore, another source of lead must have been added. It is extremely unlikely that Pb was introduced as an impurity with copper considering that in most of the seven analyses of glazes there is more lead than copper. Probably lead was added to the frit batch as red lead oxide, Pb_3O_4, considering that this was the source of lead used by other potters in Pakistan. The Quetta glazes have very similar compositions to the Multan glazes, and the batch addition of Pb_3O_4

in Quetta is about 7 percent, so it can be reasonably assumed that this was also the case in Multan.

The presence of a small amount of lead, .04 molecular equivalents, in both Multan and Quetta glazes (Table 14) would assist slightly in healing of surface irregularities; make the glaze slightly more brilliant; and in the presence of some colorants, most notably Cu, modify the color of glaze or underglaze decoration. In Multan ware the presence of PbO in the glaze accounts for slightly greenish tinge of the turquoise blue–copper color underglaze pigment. Were lead not present, this color would become more vividly bluish.

As seen in Table 14, the average SiO_2 content from seven Multan glazes is 2.90 molecular equivalents compared to 1.82 for the unfired Multan glaze based on an average of three analyses. This silica enrichment of the fired glaze was anticipated (p. 147), where it has been noted that observations of the fired glaze with a microscope show reaction-rounded quartz grains in the slip layer. The siliceous slip batch consists of 50 percent glaze, 50 percent ground quartzite, so during firing the portion of slip that is identical to the overlying glaze could be expected to exhibit fusion behavior similar to that of the glaze itself. The glaze begins to fuse at a low temperature of about 700°C; and the ware is fired to 950°–1050°C so the extent of silica enrichment shown by the analyses is to be expected.

Other changes between compositions of the unfired glaze powder, and fired glaze on vessels can be seen in Table 14. Increased concentrations after firing are shown by SiO_2, CaO, and K_2O. MgO and Na_2O have decreased concentrations. In order to determine the extent to which reaction between glaze and slip, and glaze and body, contribute to these concentration changes, sample 18 is important (Tables 12, 13). This is an analysis of a piece of glaze removed from the underside of a bowl, where the glaze had been applied directly on the body, so the glaze was not in contact with slip. Compared with other sample analysis of USNM 417,190, sample 18 shows an average SiO_2 content, high Al_2O_3, high FeO, low MgO, low CaO, distinctly high Na_2O, low K_2O, high TiO_2, and low P_2O_5. Thus, it can be concluded that reaction between glaze and body increases the concentration of Al_2O_3, FeO, Na_2O, and TiO_2. Changes in concentration of other oxides in the fired glaze may then be considered to result from reaction between glaze and slip, where the enrichment of the glaze in SiO_2 causes a corresponding dilution of concentration of other oxides.

Without quantitative analyses of the complex materials used in the Multan glaze batch of quartzite, plant ash, possible glass cullet, and an unknown source of lead, it is not possible to state absolutely whether or not the batch compositions given by Khuda Baksh are confirmed by glaze analyses, except to say that analyses of the fired glaze show a lead content which cannot be accounted for by any of the batch materials supplied by Khuda Baksh. On the available evidence, however, his description of glaze preparation is reasonable. First plant ash and quartzite, 50 percent of each, are sintered at about 900°C. The other materials added to the frit batch include borax and a source of lead, probably red lead oxide (Pb_3O_4). The analytical results cannot at this stage indicate conclusively whether or not glass cullet has been added to the batch, but it is certainly possible.

The colorants used for underglaze decoration have been shown by analysis to be consistent with the data provided by Khuda Baksh. The turquoise blue color (samples 2 and 24) was due to copper oxide. SnO_2 content increased when there was a significant copper content indicating that the SnO_2 was added as an "impurity" with the copper oxide. This is confirmed by the analyses of Multan copper scale used in pigments. Those analyses show that a small amount of Zn was also present as an "impurity" with the copper oxide, so small amounts of Zn would also be present in the Multan glazes containing copper.

The cobalt blue color was due to a mixture of cobalt and copper oxides and there is no reason to doubt Khuda Baksh's data, referring to a mixture of four parts cobalt oxide, one part copper oxide (p. 99), for the raw pigment.

The iron content of the glazes is high enough to contribute to the color of the glaze, which in areas where underglaze pigments are absent is best described as an extremely pale blue-green rather than white.

It is interesting to note that although the blue and turquoise pigments are applied as a separate layer (on decorated areas only) between slip and glaze, that the colorants have diffused into the glaze itself, over decorated areas, to a quite significant degree.

Conclusions from the study of the Multan frit and glazes are as follows:

1. The analytical results are consistent with the glaze batch compositions given by Khuda Baksh of Multan, except in one important respect: seven analyses of fired glazes show an average of 3.3 percent PbO, and none of the materials mentioned by Khuda Baksh contain PbO. It is concluded that lead probably as red lead oxide (Pb_3O_4) is added to the second frit batch, probably in the order of about 7 percent of the batch.

2. Analyses of fragments of glaze removed from

areas above brush work decorated areas confirmed that Cu and mixtures of Co and Cu were used for turquoise and blue colored decoration, respectively. SnO_2 was introduced as an impurity with Cu.

3. Borax is added to the frit batch; low summations for analysis are due to the presence of boron which could not be detected with the available analytical facilities.

4. The analyses of fired glazes give compositions resulting from reactions between the glaze and body to the slip and pigments during firing. Further studies of the quantitative composition of batch materials, and of the kinetics of the high temperature reactions between glaze and body and slip, are necessary.

QUETTA GLAZES.—Four analyses of Quetta glaze samples are given in Table 12. Samples 20 and 22 are of a green glaze and samples 23 and 25 are of a brown glaze. Apart from the colorants, both glazes have an overall similarity; fluxes are Na_2O, K_2O, CaO, MgO, and PbO; and SiO_2 content is similar in both. A detailed comparison of the analyses, however, shows that the two glazes are distinct from one another in many respects.

The most obvious differences are more clearly seen in Table 13, where the compositions can be compared on a direct basis as molecular equivalents of oxides. USNM 414,542, the green glaze, colored primarily by CuO, has lower SiO_2 and Na_2O content than USNM 414,547, the brown glaze colored primarily by MnO. The green glaze has higher Al_2O_3, FeO, MgO, CaO, and PbO content; and P_2O_5 and SnO_2 are present in the green glaze in low amounts but present only in trace amounts from the brown glaze, which for all practical purposes of affecting the chemical reaction may be viewed as absent. What are the reason for these differences?

The most immediately noticeable feature of the four samples given in Table 12 is the low summation of each, lower in fact than for any of the other analyses except samples 7 and 8 of Hala frit. Limits of analytic precision can be calculated for these totals from data at the end of Appendix 4. The true summations would then fall within the range: sample 20, 87.3–94.1 percent; sample 22, 86.5–93.2 percent; sample 23, 83.7–90.2 percent; and sample 25, 82.4–88.4 percent.

From the batch composition given by a Quetta potter (glass cullet, 8 parts, 57.15 percent; borax, 4 parts, 28.57 percent; red lead oxide, 1 part, 7.14 percent; colorant, 1 part, 7.14 percent), it can be calculated that the glazes should contain 10.43 percent B_2O_3, which would bring three of the totals to 100 percent within the limits of analytical precision. Thus, the presence of borax, not detectable with our analytical facilities, can account for the low summations in samples 20 and 22, which are in good agreement with the potter's stated batch composition. This amount of borax, however, still leaves a low average summation for samples 23 and 25 of a brown glaze.

The higher Na_2O content shown in samples 23 and 25 suggests the possibility that a borax addition of greater than 28.57 percent may have been made to this glaze batch than that represented by samples 20 and 22; in this case the B_2O_3 content for samples 23 and 25 could be higher than the above-calculated 10.43 percent, bringing the summations to 100 percent.

The color of the green glaze examined by samples 20 and 22 is due primarily to the presence of copper, modified by a smaller iron content. Analysis of the copper scale colorant (Table 9) shows that Al, Ca, Fe, Si, Sn, and Zn are present in the Quetta copper scale and thus would be introduced in minor amounts to the batch by use of this copper scale as a colorant. The CuO content of the glaze, within reasonable limits, is consistent with the batch composition given by the potter where about 7 percent colorant was added.

The color of the brown glaze analyzed in samples 23 and 25, is due to MnO, of which about 4 percent is present. Analyses of the brown colorant show that Al and Zn would also be introduced to the batch with the colorant. As Zn was not determined in our analyses, its concentration cannot be specified, but it is probably low (less than 1 percent). Other colorants present are FeO and CuO.

The presence of an average of 1.44 percent of CuO in the brown glaze is inconsistent with the composition given by the potter. Probably copper scale was mixed with the brown colorant before addition to the glaze batch; Cu would not be contributed by any of the other batch ingredients of the brown glaze. Again, the overall colorant concentration in the glaze is consistent with the potter's batch composition for the glaze where about 7 percent colorant was added.

In order to compare further the potter's stated batch composition with the analyses of fired glazes, it is necessary to know the composition of all the batch materials. Analysis of the red lead of USNM 414,555, showed that this can be taken as Pb_3O_4 with less than 1 percent impurities. Analyses of the colorants has already been discussed. The borax is hydrated sodium metaborate, $Na_2B_4O_7 \cdot 10H_2O$. The composition of the glass cullet is unknown; so precise calculations relating the potter's batch compositions to the fired glaze cannot be made. If an assumed composition

for cullet is taken as 0.5 CaO, 0.5 Na_2O, 0.5 SiO_2, then it can be calculated from the batch composition that the constituents of the glaze batch should be: Na_2O= .54, SiO_2=.82, B_2O_3=.26, CaO=.41, PbO=.05.

Compared with actual analyses of the fired glazes, this calculation gives a very low SiO_2 figure, indicating first that the cullet used in Quetta probably has a higher SiO_2 content than the theoretical composition; and second that the glaze has reacted with SiO_2 in the slip applied to vessels during firing. The calculated PbO and CaO values match well with the green glaze, but the Na_2O is high; this is indication that the glass cullet contains MgO and K_2O.

The calculated Na_2O value matches with the brown glaze but it has been stated above that the brown glaze had a larger Na_2O content because extra borax was present; so when the Na_2O, due to borax, is subtracted the calculated Na_2O is higher than the actual, indicating that the glass cullet contributes MgO and K_2O.

The source of P_2O_5 in the green glaze is a puzzle. The only batch material likely to contribute P_2O_5 is the cullet, particularly if the cullet was locally made glass in which plant ash may have formed part of the glass batch.

So at this stage the conclusions regarding the glass cullet are that it contributed Na_2O, K_2O, MgO, and CaO as fluxes, and SiO_2 and possibly P_2O_5 to the glaze batch. Other conclusions from the preceding reasoning are that the brown glaze had a larger batch addition of borax than the green glaze; and that the colorant additions to the glaze batch are consistent with the quantities stated by the potter.

Two further problems arise with the comparative compositions of the green and brown glazes. One is the difference in PbO content, averaging 4.45 percent in the green glaze and 1.36 percent in the brown glaze. According to batch compositions the PbO content of both glazes should be equal. The other problem is the difference in SiO_2 content between the two glazes. Godden (pers. comm.) observed the complete glaze-making process in Quetta, and states positively that the glaze batches were compounded in accordance with the potter's stated materials and quantities. Therefore, the one possible explanation for the variation, that is different batch additions, seems unlikely. It is quite probable that small variations in composition are introduced during the weighing of materials for the batch (Plate 51*a*). The simple fulcrum scales could be estimated to have an error of plus or minus 5 percent. This would account for variations in the borax content between the green and brown glazes, just mentioned; it also would partly account for variations in PbO content between the two glazes.

The explanation for varying PbO content, which best fits all the data, is that the brown glaze was fired to a higher temperature than the green. This is evident when the two vessels from which samples were taken are examined; the brown glaze on USNM 414,547 (Plate 54*a*) has flowed extensively. No flow is noticeable on the green glazed vessel USNM 414,542 (Plate 54*b*). This volatilization of lead from glazes has been extensively discussed (p. 148); coupled with weighing errors for the batch it can account for the lower PbO content of the brown glaze. Further evidence for the varying PbO content is provided by the higher SiO_2 content of the brown glaze, which is consistent with higher firing producing an increased reaction with body and slip, and enrichment through lead volatilization.

The glazes contain lead, so the possibility of toxicity from lead release arises. The Mellor ratio (p. 148) for the green glaze is 0.39, which is safely below the limit of 0.5. But the presence of copper in the glaze would increase lead release. Further likelihood of danger is indicated by the glaze batch itself, where the lead is introduced raw, the glaze batch not fritted. The brown glaze by these standards has acceptable characteristics. The green glaze should be further tested empirically for lead release before being declared safe or unsafe.

Conclusions from the studies of the Quetta glazes are as follows:

1. Analyses of four samples of two Quetta glazes showed them to be similar in overall composition. Differences were primarily due to the use of different colorants, copper scale for a green glaze, and mixed MnO-CuO colorant for a brown glaze.

2. Other differences between the brown and green glazes were due to minor violations in batch composition, probably due to weighing errors and to differences in firing temperatures.

3. Within the limits of investigation, the batch composition given by the potter can be related to the fired glaze composition. The fired glaze composition is influenced by reactions between glaze, and slip and body, and by volatilization (primarily of lead) at high temperatures. It has been noted in the preceding discussion that analyses of fired glazes by electron microprobe reflect three distinct sets of variables: (a) *initial composition* of the glaze before firing; (b) changes from initial batch composition due to *volatilization* of some glaze constituents, particularly PbO, at high temperatures; and (c) changes from initial batch composition due to *reaction* of the glaze, with body, slip, and pigments during firing.

Comparison of Pakistan Fired Glazes

To obtain data characterizing the compositional changes occurring in the glaze during firing, and due to volatilization or reaction processes, it would be necessary to have complete analytical data for glaze, slip, pigment and body materials before firing, and to study the glaze composition variation with temperature throughout the fusion range of the glaze. Such complete data is obviously not available in the present study. So before making comparisons between glazes of different areas, it is necessary to evaluate briefly the nature and reliability of data obtained from electron microprobe analyses of fired glazes.

The primary aim of these analytical studies has been to establish whether microprobe analyses provide data by which glazes for vessels from different areas of Pakistan can be distinguished from one another, and also to establish the extent to which glaze analyses can be related to the known techniques of glaze preparation. The latter question has been extensively discussed above. It is now necessary to evaluate systematically these specific questions: (1) Does the composition of glazed samples removed from different portions of the one vessel vary; if so, why? (2) Does the composition of glazed samples removed from different vessels from one glazing technique vary; if so, why? (3) Can glazes from vessels from different areas in Pakistan be differentiated on the basis of data obtained from electron microprobe analyses?

It can be seen from the analyses given in Table 12, when each specific sample is related to the location on a vessel or tile from which it has been taken, that the samples are not directly comparable with one another because of the presence of colorants. The colorants have been either introduced directly into the glaze batch or are present in the fired glaze as a result of reaction with pigments or colored slips. For comparison of glazes, it is normal practice to express the composition as molecular equivalents of oxides, known as the "Seger Formula," as in Table 13 which has been calculated from the data in Table 12 (Parmelee, 1951:38–52).

The specific analyses upon which these data are based are indicated in Table 13. In order to calculate this data, the composition of each glaze in Table 12 was recalculated as molecular equivalents of oxides, by the standard convention of the sum of flux group (in this case, Na_2O, K_2O, CaO, MgO, and PbO) equals unity. Colorants except FeO, MnO, CoO, Cr_2O_3, CuO were omitted from the calculations; their omission does not change the ratios. The effect of their presence in individual samples already has been discussed above. The complete results of these calculations are given in Table 13. From this data, composition ranges were selected to calculate average compositions, which are given in Table 14. Unusual compositions were omitted, for example sample 12, one of the three samples removed from a tile from Hala, because the PbO shown in this analysis was present as a color modifier in the pigment underneath the glaze coating, and was not a constituent of the glaze as a whole.

The Multan frit, studied, in sample 6, was omitted, because it was collected from a different potter than the other samples; this applied also to Hala frit studied as samples 7 and 8. Working techniques differ between the potters, so a definite correlation between the composition of these frits and that of other sample Hala and Multan glazes could not be established. The overfired glaze examined in samples 13 and 16 from Zakhel Bala has also been omitted because, being known to be overfired, the glaze was of an abnormal composition.

The three basic questions just raised can now be evaluated. It is clear from Table 12 that the composition of fragments removed from different parts of one vessel vary in the content of colorants where the presence of the colorant is due to reaction with different underlying slips and pigments, such as USNM 417,190 from Multan, or USNM 417,113-A,B from Hala. In such a case, the variation is readily explained. Where the colorant is actually added to the initial glaze batch, as in the Quetta glazes, the analyses of different fragments from the same vessel give similar values for colorant content. When basic glaze compositions are examined with colorants removed, in terms of the basic glass-forming constituents, the compositional variation between fragments removed from a single vessel are within very narrow limits for most elements. This is most clearly seen in Tables 13 and 14. For individual oxides, the greatest variation among samples removed from a single vessel is seen with SiO_2 and Na_2O. CaO also shows variation within narrower limits.

Do compositions of samples from different vessels from one area in Pakinstan vary? From Tables 13 and 14 it can be seen again that there are significant variations in SiO_2, CaO, and Na_2O, but that overall analyses are very similar. Compare, for example, four samples of USNM 417,190, with three samples of USNM 417,193-B. Apart from the SiO_2-CaO-Na_2O variations, variations in other oxides are of the order ± 0.01 molecular equivalents. Variations in SiO_2 are of the order ± 0.2 molecular equivalents; Na_2O

TABLE 15.—*Compositional indicators for differentiation of recent glazes from Pakistan, expressed as range of molecular equivalents*

	ZAKHEL BALA and PABBI	HALA		MULTAN	QUETTA
MINERAL COMPOSITION	Lead glazes	Lead glaze	Alkaline glaze	Alkaline glaze **	Alkaline glaze **
SiO_2......	1.60 - 1.62†	1.26 - 1.45†	3.04 - 3.34	2.71 - 3.09	2.69 - 2.88
Al_2O_3.....	0.13 - 0.14†	0.04 - 0.07	0.05 - 0.11	0.05 - 0.08	0.05 - 0.06
MgO.......	0.03	0.03	0.01 - 0.03	0.10 - 0.17†	0.04 - 0.07†
CaO.......	0.02 - 0.06	0.03 - 0.08	0.05 - 0.14	0.24 - 0.32	0.32 - 0.48
Na_2O......	0.03 - 0.11	0.02	0.75 - 0.87†	0.38 - 0.53	0.28 - 0.50
K_2O.......	0.02 - 0.06	0.01	0.06 - 0.10	0.08 - 0.13	0.12 - 0.17
TiO_2......	0.02 - 0.03†	0.01	0.00 - 0.01	0.00 - 0.01	0.01
P_2O_5......	absent	0.00 - 0.01	absent	0.00 - 0.01	0.00 - 0.01
PbO.......	0.74 - 0.90	0.86 - 0.91	0.00 - 0.01	0.03 - 0.05	0.01 - 0.07
B_2O_3*.....				0.22(?)	0.50 (?)

Values with dagger (†) show greatest discrimination of that glaze from all others; minor discriminations indicated by underscore; all other data indicate overlapping values.

* B_2O_3 values are theoretical and thus suspect.

** For further discrimination between Multan and Quetta alkaline glazes, note variations in colorant content (Cu, Co, Mn, etc.)

about ±0.06 molecular equivalents, and CaO ±0.03 molecular equivalents.

Do these variations permit differentiation of glazed vessels from different areas of Pakistan on the basis of composition of fired glazes? Lead-fluxed glazes from two locations, Hala and Zakhel Bala and/or Pabbi, near Peshawar, show very similar compositions overall (Table 14). Both are characterized by the predominance of PbO as the primary flux, 0.89 molecular equivalents in the Hala lead glazes and less (0.82) in the Zakhel Bala glazes. Conversely, the Zakhel Bala glazes have higher SiO_2 of 1.61 molecular equivalents versus 1.34 in the Hala glazes; Al_2O_3, Na_2O, and TiO_2 are also higher in the Zakhel Bala glazes. The compositions suggest a slightly higher firing temperature for the Zakhel Bala and/or Pabbi glazes than for those from Hala, particularly when the glaze batch compositions are considered; the Zakhel Bala glaze batches probably being similar to that of Hala.

The composition range can also be considered in these comparisons. There is overlap in the PbO content; also for SnO_2, CaO, MgO. There are no overlapping values for SiO_2, Al_2O_3, FeO, Na_2O, K_2O, TiO_2, P_2O_5. So differentiation can be made on the basis of the latter group, particularly SiO_2 and Al_2O_3, and possibly the presente and/or absence of P_2O_5.

All other glazes can be distinguished immediately from the Hala and Zakhel Bala and/or Pabbi lead glazes by the absence or low content of PbO (Table 14). The average Hala alkaline glaze is distinct from all other glazes because of the high Na_2O content; 0.82 molecular equivalents against 0.42 for the Multan glazes and 0.39 for Quetta glazes; and the high SiO_2 average value, 3.22 molecular equivalents against 2.90 for the Multan average and 2.79 for Quetta. The SiO_2 values for these three alkaline glazes of around 3.0 molecular equivalents were much higher than those for the lead glazes (1.61 Zakhel Bala and Pabbi, and 1.34 Hala).

Compared again with the Multan and Quetta alkaline glazes, respectively, the Hala glazes were lower in MgO and lower in CaO. The K_2O average was intermediate between that for the Multan and Quetta glazes, but by general glaze standards was low at only .08 molecular equivalents.

A completely unexpected outcome of the analyses was that the average composition of the Multan fired glazes was almost identical to that of the Quetta glazes. The values for SiO_2, Al_2O_3, Na_2O, K_2O, TiO_2, P_2O_5, and PbO were almost exactly duplicated. CaO and MgO values were different but the sum of the average values of these two oxides, which behave very similarly in glazes in many cases, was again almost duplicated. So although the wares of Quetta and Multan are very readily distinguished on a

stylistic basis, the basic glaze compositions are very similar. Compositional distinctions are most readily made on the basis of the colorants present and the variation in content of these on one vessel due to the different uses of colorants in the two areas.

In terms of compositional range, the glazes of Multan, Quetta, and Hala show no overlap for these oxides: MgO (Hala vs. Multan and Quetta), CaO (Hala vs. Multan and Quetta), Na_2O (Hala vs. Multan and Quetta). Thus these three oxides can readily differentiate Hala ware from that of Quetta and Multan (Table 14).

The distinction between Quetta and Multan ware is much narrower. In terms of compositional range, colorants can be used; MgO is higher for Multan than Quetta. If B_2O_3 could be determined, its content in the Quetta glazes would probably be higher than in Multan glaze.

In summary, distinctions between all glazes other than those of Quetta and Multan can be readily made on a compositional basis. The latter two may be differentiated on a glaze compositional basis, but stylistic differences provide more reliable discriminations. Compositional indicators for differentiation are summarized in Table 15.

The following conclusions may be drawn from the above comparison:

1. Variations in colorant content between samples taken from different areas of one vessel can be related to the visual appearance of these areas, and only in rare instances change the nature of the basic glaze (less colorants) for a sample. Such an example has been noted, where lead oxide was used in a pigment to modify the color underneath an alkaline glaze.

2. If glaze compositions are expressed as molecular equivalents of oxides, glaze composition of samples from different areas of Pakistan can be readily differentiated, except for differentiating Multan and Quetta alkaline glazes, which have very similar compositions. The latter can be distinguished readily on stylistic differences of the wares and from colorant compositional differences.

3. Variations in composition of different samples of glaze removed from a single vessel, or from different vessels made in the same technique by the same potter, are primarily due to reactions with different pigments or colorants under the glaze. The basic glaze composition varies only within limits which are very much narrower than compositional variation of glaze samples removed from vessels from different regions of Pakistan.

4. The value of the electron microprobe as a research tool in the comparison of glazed ware has been demonstrated, and the techniques developed and used for the present study could find further applications in time or area-based comparisons of glazed ware.

Summary of Study of Pakistan Glazes

Semiquantitative composition of some raw materials, one from Quetta and five from Multan, have been given.

Fusion experiments with Multan glaze materials have confirmed data on glaze preparation given by a Multan potter. Experimentally determined estimates of temperatures involved in preparation of frits are given. The firing temperature of Multan ware is between 950° and 1050°C.

Firing temperature for Zakhel Bala lead-glazed ware is also estimated at 950°–1050°C, although an overfired vessel was found to have been heated to 1100°–1200°C. This high temperature must only have been reached in a localized overheated zone of the kiln. Hala lead-glazed ware is fired to a lower temperature than that of Zakhel Bala.

Twenty-nine analyses of fired glaze fragments, and frits, are given. The composition of fired glazes was found to be different from that of the original glaze batches, because of (1) volatilization of Pb from high-lead glazes at high temperatures; and (2) reactions between glaze and body, slip and pigments, during firing.

In order to fully understand the relationship between glaze batch composition before firing and the fired glaze, it would be necessary to study the detailed kinetics of these compositional changes during firing.

The glaze batch compositions given by Pakistan potters have generally been confirmed by the analytical studies. Lead, the presence of which was unsuspected, was present in Multan glazes. Because of variations in technique among Hala potters, the data supplied by a Hala potter could not be applied to samples made by other potters.

Low analytical summations of some glazes, which could not be explained by variations in precision of the analyses, are thought to be due to the presence of boron. This element could not be determined with our analytical facilities.

Compositional characteristics which allow differentiation of glazes from Zakhel Bala and Pabbi (lead glaze), Hala (lead glaze), Hala (alkaline glaze), Multan (alkaline glaze) and Quetta (alkaline glaze) have been isolated. These new data may be used for comparison of these glazes with glazes from other areas, or other time periods.

The electron microprobe thus can provide extremely useful data for comparison and classification of glazed ceramics.

KILNS AND FIRING

Many distinctions between the working techniques of potters making unglazed ware and those producing glazed ware have been made. The distinctions are most strongly accentuated in kiln types and firing techniques. To demonstrate these differences, the essential characteristics of different firing methods are examined.

Saraswati and Behura (1966) have classified firing methods of Indian potters in three types: firing in the open, firing in an oven, and firing in a kiln. While this classification is also satisfactory from a descriptive point of view for firing methods used in Pakistan, it overlooks some essential technical characteristics of different firing methods. Pakistan firing techniques can be divided into two major categories: (1) fuel and vessels set together, either in the open or partially enclosed by permanent walls; and (2) fuel and vessels in separate chambers of a permanent structure, a kiln.

For convenience these categories of firing technique may be called, respectively, "mixed" and "divided."

Technically, the firing of pottery may be regarded as the establishment of a set of conditions under which bodies or glazes undergo reactions permanently changing their physical state. The essential variables are time, temperature, and atmosphere to which the pottery is exposed. These variables are not independent of one another. For example, the atmosphere, or the products of combustion at any given temperature, is governed by the type of fuel, degree of mixing of air and fuel or the degree to which theoretical perfect combustion is attained, and the air-to-fuel ratio governed by the rate of supply of air to the fuel. Changes in temperature can change the nature of the atmosphere, as for example in the well-known CO-CO_2 equilibrium which is temperature dependent.

For the skilled potter, the control of firing is through choices of fuel, control of access of air to the fuel and the rate at which fuel is supplied, the duration of firing, and the methods of insulation to prevent heat losses during firing. The discussion of kiln types must, therefore, take cognizance of these factors.

In the Pakistan mixed kilns used for unglazed ware, essentially the only control the potter has over firing is during setting, i.e., in the choice of fuel and the closeness of setting of vessels and fuel. The access of air to the fuel, in most firings of this type, cannot be altered during firing. The duration of firing is determined by the amount of fuel set in place before beginning the firing, since no fuel is added during firing. The rate of heating, and evenness of heating throughout the setting, is also determined before firing by the type, amount, and evenness of distribution of fuel. In many versions of this type of firing some degree of insulation is provided during setting to retain the heat. A layer of sherds, earth, stone, wet straw, or thick layers of fuel may be placed over the setting as insulation. Naturally, if this insulating layer is combustible it burns away as the firing progresses.

The Pakistani divided kilns are in complete contrast. In these updraft, or modified updraft, kilns the vessels are set in a chamber near the top of the kiln. Fuel is burned in a separate chamber called the firebox. The flames pass upwards through an opening in the floor of the upper chamber, traveling around the vessels to flues at the sides or top of the kiln.

These flues can be partially closed off to control the draft of the kiln. The amounts of fuel and air can be varied during the firing, and the firing can be terminated by ceasing to add fuel and/or closing off air access. Insulation is provided by the permanent structure of the kiln. Access to the chamber is by an opening at either the side or top of the upper chamber. This opening is sealed with bricks, if at the sides, or covered with sherds or tiles if at the top, to prevent heat loss. The divided kilns thus offer the potter a considerable degree of control during firing.

Unglazed ware in Pakistan is almost universally fired in mixed firing and glazed ware always in divided firings. Exceptions for unglazed ware were noted with the specialized ware of Ahmedpur East, the paperfine ware, fired in simple updraft kilns, and in Bannu where the potter Mir Shad was also using an updraft kiln.

Fuels and Their Consumption

The two most common fuels used by Pakistani potters are dung mixed with straw for mixed firings, and wood for divided firings. Dung fuel is obtained initially as droppings from donkeys and buffalo, and is commonly prepared by mixing with chopped straw, forming cakes and sticking these to a wall to dry in the sun. The fuel is only suitable for use when completely dry. Usually the work of mixing dung and straw, and drying and carrying the fuel is done by women or children of the potter's family.

Potters consider dung to be a very good fuel for mixed firing because it is either free or very inex-

pensive, very readily available, and slow burning, raising the temperature steadily with an even temperature distribution throughout the setting. To most potters who use it, dung is not a substitute for a better fuel, but is the best fuel for their techniques.

Other fuels will be discussed in relation to specific firing techniques. A short list of plant fuels used by Pakistani potters is given in Table 5.

The consumption of fuel per firing for various firing techniques has been given in the description of individual potter's techniques by geographical region. Estimates given by potters vary in reliability; where fuel is bought by weight, estimates can be considered quite accurate, but where fuel is gathered or obtained free and not weighed the estimates could be quite inaccurate.

Taking this into account, the reliable data on fuel consumption is limited. In a few cases where firings were observed from start to finish, it has been possible to confirm potters' estimates. In the same way, it has been possible to obtain relatively accurate estimates of the amount of body used for vessels included in one firing. On examination of the data for body and fuel consumption, there is evidence that more complete data could provide an efficiency ratio, which is the ratio of body fired to fuel consumed per firing.

Four mixed firing techniques, where the fuel is dung and straw, are described as a single, normal firing. In Dir, using a *pajā* type kiln, Khan Zada sets about 285 kg of vessels with 100 kg of fuel, giving a body to fuel ratio of 2.8/1. At Musazi, Abdul Janab uses 8160 kg of vessels, 3265 kg of fuel, giving a ratio of 2.5/1 for a *pajā* kiln. At Shahdiwal, for an *āvī* firing, 2130 kg of vessels are set with 630 kg of fuel for a ratio of 3.1/1. At Gujrat, in the *kūp* kiln, Sardar Mahommed sets 540 kg of vessels, 270 kg of fuel, giving a ratio of 2/1. (Note that the weights in kilograms are calculated from the potter's esitmates in maunds (Glossary), and do not have the accuracy suggested. They are probably accurate to ± 10 percent.)

The most interesting implications of these ratios is that they can be ranked according to the insulating and air supply sophistication of the firing techniques. The *āvī* can be expected to be the least efficient firing technique and the *kūp* the most. The ratios for *āvī*, *pajā*, and *kūp* are 3.1, 2.8, 2.5, and 2.0, respectively. The ratios would have greater significance if maximum firing temperatures for these three techniques were known, but are valid in the sense that the ware in each of these firing techniques was considered by the potters as well fired.

Only two reliable estimates of the quantity of body fired versus fuel consumption are available for firing glazed ware in updraft kilns. At Zakhel Bala, about 1600 kg of vessels are fired with 500 kg of wood fuel, giving a ratio of 3.2/1. At Gujrat, a large updraft kiln in which small whiteware bowls are fired is set with about 1800 kg of vessels and a firing uses about 700 kg of wood, a ratio of 2.6/1.

With the limited data and many variables influencing the pottery to fuel, or "efficiency" ratio, it is not possible to draw strong conclusions from this data. It is obvious that in terms of weight, having implications for transport, the potter uses two to three times as much body material as fuel. There is evidence that the potter who uses a mixed firing technique uses less fuel with better insulated firing and improved air supply. Further investigations of potters' techniques in this area may provide fruitful data which could be particularly valuable in archeological studies where data on use of resources by the potter is required.

Firing of Unglazed Ware

Mixed Firing

It is tempting to speculate on the relationship of the many firing methods to one another in terms of the evolution of types. A logical progression can be established, from the open bonfire to the pit-kiln (*āvī*) to the enclosed kiln (*pajā*) and finally the enclosed kiln with air vents underneath (*kūp*), which with further modification could become an updraft kiln. In fact one potter, Mir Shad of Bannu, is using an updraft kiln to produce ordinary domestic unglazed ware, so the sequence from the simplest possible firing to the technically sophisticated updraft kiln is complete. Unfortunately, the speculation that kiln types can evolve needs archeological evidence, which for Pakistani kiln types is not available.

The simplest firing technique is used by Mehrab Shah of Seen, in Chitral valley, who fires vessels in a bonfire using wood, the most readily available fuel. Significantly, he fires on a flat area of ground with no permanent structure except a shallow circular depression, and after firing removes the wood ash for use as fertilizer on the fields. Thus, this type of firing leaves very little evidence from which future archeologists could deduce firing methods.

Noor Khan of Bomboret fires ware in a pit. His production rate is very low, so each time he fires vessels he digs a pit of the correct size for the number of vessels to be fired. The pit is lined with pieces of slate and after prolonged preheating to 400°–500°C, the vessels are set in place and the interstices filled with the pine-bark fuel. The setting is then covered with slate as insulation. These two simple firing tech-

niques are used by part-time potters, both producing very limited numbers of vessels, and both working in the extreme north of Pakistan. The distribution of these techniques is extremely limited.

The most common method of firing in the Northwest Frontier Province is in the *pajā*, a type of kiln with the only permanent structure being four walls, the front wall about half the height of the others. The walls are normally built from stone, but mud is used where stone is unavailable. Many potters economize in the construction of the kiln by using an existing wall or corner of their house as one or two walls of the kiln. This type of kiln is also found in Baluchistan. Very large versions of this kiln-type are used for firing large vessels (Figure 7).

The fuel for the *pajā* kiln is normally dung, mixed with some chopped straw and thoroughly dried before use. Rarely, some wood is also used where both glazed and unglazed ware are made; the potters prefer to use this type of kiln with dung fuel for unglazed ware, although they use an updraft kiln and wood fuel for the glazed ware.

The type of kiln known as *āvī*, an open shallow pit, is used widely in Panjab, and also in areas west of the Indus from Dera Ismail Khan southwards, and in Sind. The *āvī* is essentially triangular in plan and built on either a natural or man-made slope, with the apex of the triangle at the base of the slope. Fuel and pots are set in layers; the fire, which is started at the lower apex of the triangle, burns gradually up through the setting. This type of kiln exists in many stages of refinement from the most basic, which is simply a shallow open depression in the ground, to the most sophisticated, which has brick walls. The latter version is functionally very similar to the *pajā* of the Northwest Frontier Province.

The fuel used in the *āvī* type of kiln varies considerably and depends on what is available to any specific potter. Again dung is considered the best fuel but straw of various types, wood, and mixtures of fuel are used. Fuel and vessels are set in layers and, for some potters, specific setting sequences are always very strictly followed. Firing losses are often high, particularly when wood is mixed with the other fuels, due to rapid and uneven heating. In such cases losses are as high as 50 to 60 percent; similar losses can be caused by rain when the firing is in progress. Dung fuel, used alone or with straw, gives the most even heating and hence the best output. Because of the high losses with this type of firing, the firing site usually has an accumulation of sherds and broken pottery from previous firings.

Saraswati and Behura (1966) describe a variety of firing techniques similar to the *āvī* technique, but only in a very limited area are the Indian methods as simple as those used in Pakistan. Most of the Indian techniques involve the provision of air channels through the setting, and/or the addition of fuel during firing. The Pakistani techniques do not allow this degree of control, the only control over firing being in the setting. Once the burning has started, the firing proceeds with no control by the potter.

The most sophisticated mixed kiln, the *kūp*, is in use in Gujrat (Figure 14). In this kiln air access from a side opening to the setting is provided via a channel at the base of the setting. Firing losses in this type of kiln are said to be very low.

Divided Kilns

These are noted in only two areas, Bannu and Ahmedpur East (Figures 11, 15). In both areas the kilns are of the simplest updraft type, with perforated floor above the firebox, the flame during firing passing directly up through the ware and out the top of the chamber between gaps in sherds used to cover the setting.

The Bannu kiln is fired with reeds, which burn very quickly and with a very short flame, which would cause difficulties in any mixed firing. Because the technique has been handed down through generations, the potter did not know whether this kiln type came into use because this type of fuel was the only one available, or whether the kiln type was in use first and then this fuel chosen. The kiln is remarkable for its economy of construction: first a hole is excavated to form a firebox, and then earth removed from the hole is used to build the walls of the chambers.

The Ahmedpur East kilns are limited in size because the very fragile ware cannot be stacked beyond a certain height without crushing the bottom layers. Kilns of similar size and design are used to produce blackware and orangeware, the differences produced by variations in air and fuel supply during heating, and air supply during cooling.

Firing of Glazed Ware

Kilns used by glazed-ware potters in the four centers of Pakistan where studies were made (Zakhel Bala and/or Pabbi, Quetta, Multan, and Hala) are all of the divided type, conventionally known as updraft kilns. They consist essentially of a chamber, the firebox where fuel is burned with an opening at the top leading to the chamber where vessels are set for firing. Kilns from these four centers are shown in Figures 18, 21, 32, and 35.

The fuel for all these kilns is wood. The types of wood in common usage are listed in Table 5. Coal fuel is not used by any glazed-ware potters, although it is used in modern brickworks in Pakistan.

The potters have ditsinct preferences as to which type of wood is best for firing, prefering those which burn with a long clear flame, such as *s̱hīs̱ham* (*Dalbergia sissoo*), to others which burn with a short flame, such as the pinewoods. Despite their knowledge that some types of wood are better fuels than others, the potters have to use types of wood that are available and can be purchased economically. Usually the wood is purchased as split logs, or branches; in 1971 the Zakhel Bala and Pabbi potters began to use offcuts purchased from a furniture factory. The wood is sun-dried by all potters before use, and never burns green or wet.

Characteristically, intermittent stoking with wood fuel leads to variations from oxidizing (just before stoking) to reducing (just after stoking) conditions in the kiln atmosphere. The Pakistani glazed-ware potters overcome this by their common method of stoking (adding wood as the kiln is being fired): fuel is placed only at the stokehole, the *entrance* to the firebox, rather than being pushed right inside. As the firing progresses the amount of fuel is increased by adding extra logs at the top of the pile. Larger pieces of wood are used soon after the beginning of firing and smaller ones toward the end. The amount of wood placed on the fire at any one time is very small in relation to the amount of fuel already burning. The lower chamber, the firebox, is not acting as a fireplace where fuel is placed, but rather as a mixing chamber where the flame from fuel burning at the stokehole circulates so that it becomes even in temperature. The amount of heat passing through separate flues in the floor, and up to the pottery above, is therefore equalized.

The Zakhel Bala kilns are essentially the simplest of the four. During firing, the top opening of the kiln is loosely covered with sherds, and the flame travels directly upwards through the setting and out through spaces between the sherds. The kilns in Quetta, Multan, and Hala are more sophisticated. After setting, through the top at the Quetta and Hala kilns, or through the door of the Multan kilns, the chamber is then completely sealed. In firing the flame travels up from the firebox through flues in the floor, up through the setting, and then downwards again to flues in the side walls of the kiln. This double flame path makes greater use of the heat produced by the fuel, thus these kilns are more sophisticated than the direct updraft Zakhel Bala kiln.

Sagger refractory containers to protect ware from direct contact with the flame are not used in any of the four glazing centers. All make use of stilts and props (Plate 81) to support ware set in the kiln, and to prevent vessels coming in contact and fusing together. Use of three-pointed stilts on flatware results in the three characteristic stilt-scars, which can be seen on the face of glazed dishes, plates, and bowls.

It is most unfortunate that temperature measuring equipment was not available for the field studies. Buller's Rings, ceramic rings which shrink permanently when heated and provide temperature indications from the degree of shrinkage, measured after firing, were placed in one firing of unglazed ware at Dir. No shrinkage was found, which indicates that the maximum temperature reached was below 960°C, the minimum temperature at which these rings begin to shrink. No attempts were made to measure temperatures attained in glazed-ware firings. As previously noted, estimates of the maximum temperature attained in various glazed-ware firings in updraft kilns are as follows: in Multan, 950°–1050°C (1100°C possible); in Zakhel Bala, 950°–1050°C; and in Hala, an estimated 900°–1000°C.

Summary and Conclusions

Pottery is made throughout almost all of Pakistan. Most villages have a potter making red earthenware; some villages have many specialized potters making a limited range of ware for distribution over a much wider area than the village where they work. Traditional glazed ware is made in only a limited number of locations. The only area where there are no potters at all is in the extreme north of the country, in the Gilgit area of Kashmir. In that area, villagers use wood, leather, and modern metal (mostly aluminum) vessels for storage and food consumption, and traditional iron and stone (steatite), as well as modern aluminum, cooking vessels.

In Pakistan all potters are men. With very few exceptions potters who were interviewed said that men of their family had been potters in their village for many generations. This is evidence that many, if not most, of the potters now working in Pakistan were not involved in the mass movements of people during partition in 1947. The potter's craft in Pakistan is traditionally inherited by a son from his father. Because many potters are not training their sons, it is possible that in many areas the present generation of traditional potters will be the last.

Village potters always have their workshops adjacent to, or as part of, their houses. Only some highly specialized potters, the glazed-ware potters of Multan, have a workshop located away from their house. Except in the most highly specialized workshops, women of the potter's family, and often young children, assist with some aspect of the work, particularly the decoration of unglazed ware, and carrying vessels to and fro in the workshop between operations.

The potters make many of their tools themselves; only those which are not specific to the potter's craft, such as grinding tools, are available in the general community. Some potters in the north, particularly in Chitral, do not use a potter's wheel. Two types of wheels are used elsewhere; the single wheel, related to types in use in India, is found in Sind and the Panjab. The pit-wheel is used throughout the country; traditional wheels are made from wood with an iron point and a stone cup lower bearing. The pit-wheel is uncommon in India, and evidence suggests its derivation from Islamic pottery traditions, rather than from India. The pit-wheel is much more common in Pakistan than the single wheel.

Some aspects of the potters' technique, particularly methods of forming vessels, and firing, having distinct regional variations in Pakistan; others such as clay preparation are similar throughout the country.

Evidence suggests that the location of the potter's clay deposit is determined by the location of his workshop, rather than the opposite. Clays which cannot be used directly as dug from the deposit are modified by the addition of tempering materials. Potters making vessels or tiles, glazed or unglazed, do not use organic temper, but nonplastics, usually a locally available sand (wind or water deposited). Sands are essentially chosen because of their ready availability and because their natural particle-size distribution is well suited to the potter's requirements.

Clays used by potters all have very mixed mineral assemblages. There are no essential distinctions between clays used by glazed-ware and unglazed-ware potters. All clays except those from the far north have a significant calcite content.

Clay and body preparation techniques are similar in all areas of Pakistan. Clay is brought from the deposit, usually on donkeys. After sun drying for one or more days, the clay is broken up into small lumps with a stick. The potter then forms a hollow pile of clay, pours water into the center, and then leaves the clay until the water has evenly wetted it. Nonplastics are added by sprinkling over the wet clay. The body is then kneaded by foot. Some potters, particularly in the Panjab, prepare the clay in a shallow pit. Some potters have facilities for storage of prepared body in an underground pit. The proportion of clay to nonplastics in the body is normally determined by the potter's judgment rather than measurement, so it can vary from batch to batch.

Forming techniques for unglazed ware and glazed ware are essentially distinct from one another. Glazed ware is formed by throwing, turning, and often by forming parts of a vessel separately and joining.

A much wider variety of forming techniques are used for unglazed ware. Techniques involving the paddle and anvil are distinct in different areas. The

vessels are started by throwing a form on the potter's wheel and completed by paddle and anvil. In the Northwest Frontier Province, the initial form is thrown from a coil of clay joined to the perimeter of a clay pad resting in a shallow mold on the potter's wheel. In other parts of the country the initial form is thrown directly on the wheelhead. The Northwest Frontier Province technique is related to techniques used in Afghanistan; the more general technique is also used in India. Potters making unglazed ware use a variety of molding techniques. The most sophisticated of these is used for the paperfine ware of Ahmedpur East. Other highly specialized techniques used at Ahmedpur East make the ware from that area distinct from any other in Pakistan.

Slips are used on both unglazed and glazed ware. The common slip for unglazed ware is a red-burning clay, applied by wiping on with a cloth, dipping or pouring. For glazed ware, clay slips are used with lead glazes, and siliceous slips with alkaline glazed ware. Pigments for unglazed ware are natural minerals, of mixed composition, not refined to contain only the essential coloring elements. White pigments contain little iron; red or brown pigments have higher iron content and black pigments contain manganese in addition to iron. For glazed ware pigments, and glaze colorants, copper scale—black copper oxide formed by heating copper—is used as a copper pigment. The copper scale has significant tin and zinc contents. Imported cobalt oxide is used for blue pigments; former natural cobalt sources have not been located.

Glazed ware from the four locations of Zakhel Bala, Quetta, Hala, and Multan are included in the study. Analysis of glaze samples removed from vessels from these four areas are reported. The differences between lead-based glazes from Zakhel Bala and Hala are minor, but the wares are easily distinguished on a stylistic basis. Multan and Quetta glazes are compositionally very similar, but again vessels can easily be distinguished on a stylistic basis. The alkaline glazed ware of Multan is very similar stylistically to that of Hala, but quite readily distinguished on a compositional basis. The 29 analyses reported in this monograph are the first published for glazed ware from Pakistan and may be used as a basis for later comparative studies.

Firing techniques for unglazed ware and glazed ware are characteristically different in most respects. Mixed firing, in which fuel and vessels are set together, is the most common method of firing unglazed ware. The *paja* kiln, commonly used in the Northwest Frontier Province, is distinctly different from the *āvī,* or open pit, of the Panjab and Sind. Dung is the most common fuel for mixed firings, being preferred by the potters because of its low cost and desirable burning characteristics. Glazed ware is fired in updraft kilns, where the fuel and vessels are set in separate chambers ("divided firing"). Wood is used in these kilns as fuel. Experimental evidence suggests that the maximum firing temperature in the updraft kilns is between 900° and 1050°C.

Appendix 1

CATALOG OF PAKISTAN SPECIMENS RELATED TO POTTERY MAKING AND CERAMIC TECHNOLOGY

Owen S. Rye

This catalog lists samples or objects in the collections of the Smithsonian Institution, National Museum of Natural History, Department of Anthropology, Ethnology collections. Only specimens that have been collected by members of the four seasons of fieldwork in the Smithsonian's Ancient Technology project are included here; other specimens from Pakistan, and also from India, are in the general collections of the Department of Anthropology and are available for reference by any scholar. The catalog is further limited to include only those specimens related to pottery making and ceramic technology; it should be noted that the complete Ancient Technology project collections of four seasons fieldwork are much more extensive than the present catalog would indicate, with specimens relating to many other traditional crafts in Pakistan.

The collectors and the four seasons during which they collected are as follows: 1967–1968 collection, Hans Wulff, Don Godden, Charles Walton; 1968–1969 collection, Don Godden, Roswitha Wulff, Charles Walton; 1969–1970 collection, Don Godden, Elaine Godden, Charles Walton; 1971 collection, Don Godden, Elaine Godden, O. S. Rye, Charles Walton.

These collections were made from areas over most of Pakistan, that is, the region formerly known as West Pakistan. The collectors prepared brief field catalogs during each working season; from these catalogs, descriptions of objects were made by the museum staff for the catalog cards and accession records. The following catalog is compiled from both those descriptions and from study of the objects themselves. Most of the specimens collected in 1971 were collected personally by the senior author, whose field catalog was very brief in description. Therefore, the descriptions in the following catalog are generally more detailed than those in the Ethnology collection card files.

Several specimens in the Ethnology collection catalog of the National Museum of Natural History are omitted, because, in each case, it had not been possible to examine the object to insure that it is accurately described in the card files. In all cases, however, the card files indicate that the object in question is similar to another listed in this catalog. Some other specimens that are listed in the field catalogs are also omitted here, because the specimen in question is not in the museum's collection. Some objects were either lost or broken in transit or used up in experimental work reported in the present study. In the case where a sample was used for analytic studies, the data is reported herein.

The catalog is alphabetically arranged by collection locality. Under each locality is given the year of collection and the name of the potter who made the specimens of pottery or gave the raw materials to the investigator. When no specific potter was recorded, it is noted as "Potter Not Recorded." Samples lost in shipment from the field to the Smithsonian Institution or used up in experiment, but important to the discussion in the text, are listed by their field numbers. Field numbers followed by a single asterisk (*) indicate that the entire sample was used for analyses; those followed by a double asterisk (**) were missing from the shipment. All other items from a particular locality are sequentially arranged by their USNM catalog numbers.

Any scholar wanting to examine these objects or who wants further photographs or data about the specimens, may correspond directly with the Department of Anthropology, National Museum of Natural History, Smithsonian Institution, noting the catalog number and locality of the specimen in question. Table and plate references are given with the description of each entry that is discussed or illustrated in the text.

AHMEDPUR EAST (PANJAB)

1971

POTTER NOT RECORDED

Field 71-441 *	Clay, used without admixture for forming unglazed ware (including paper-fine ware) (Tables 6, 7)
Field 71-442 *	White pigment, for brushwork decoration on unglazed ware (cf USNM 410,652-B analysis, Table 9)
Field 71-443 *	Red pigment, for brushwork decoration on unglazed ware (cf USNM 410,652-C analysis, Table 9)
Field 71-444 *	Black pigment, for brushwork decoration on unglazed ware (cf USNM 410,652-D analysis, Table 9)
Field 71-445 *	White micaceous sand; crushed for application as a slip on unglazed ware; cf USNM 410,652-A

1967-1968

POTTER NOT RECORDED

USNM 410,652-A	Mica, white; crushed and ground for application to the paperfine ware as a slip (Plate 41*a*)
USNM 410,652-B	White pigment; crushed and mixed with water for brushwork decoration (analysis, Table 9)
USNM 410,652-C	Red pigment; raw material to be ground and mixed with water for brushwork decoration (analysis, Table 9)
USNM 410,652-D	Black pigment, raw stone, crushed and used for brushwork decoration (analysis, Table 9)
USNM 410,652-E	Anvil, fired, clay used by potters to ram clay forms into molds (for molded ware with raised clay relief decoration from incised decorated molds) (Plates 41*d* (molds), 80*c* (*anvil*))
USNM 410,652-F	Pointed steel tool used to carve or pierce relief decoration on paperfine ware (Plate 44*d*)
USNM 410,652-G	Dish, unglazed utilitarian domestic ware, red slip, black brushwork decoration (Plate 45*b*)
USNM 410,652-H	Water jar, unglazed earthenware (domestic utilitarian ware); black, white, and red brushwork decoration (Plate 45*c*)
USNM 410,652-I	Cooking pot, incised bands, micaceous slip(?), black slip on upper exterior surface, glazed on interior and rim; maximum diameter 27 cm, height 15 cm
USNM 410,652-N	*Surāhī*, unglazed earthenware (blackware), open base (possibly to allow use as lantern), pierced relief decoration (Plate 43*a*)
USNM 410,652-O	*Surāhī*, unglazed earthenware (orangeware, double-walled (annular water-containing section with molded and perforated discs, foot and neck attached separately)); micaceous slip; Perforated decoration accented with white, black and red pigment brushwork (Plate 42*a,b*)

1971

POTTER NOT RECORDED

USNM 417,164	Flower vase, unglazed earthenware, (blackware), carved relief decoration (Plate 44*c*)
USNM 417,167	Plate for hanging as wall plaque, unglazed earthenware (blackware), molded and carved relief decoration (Plate 44*a*)
USNM 417,168	Wall plaque, unglazed earthenware (blackware), molded relief decoration
USNM 417,169-A, B	Dish (A) with lid (B); unglazed earthenware (orangeware), molded relief decoration, red, white and black pigments (Plate 44*b*)
USNM 417,170-A, B	*Surāhī*, unglazed earthenware (orangeware), carved relief decoration with piercing; red, black and white pigments (Plate 43*c*)
USNM 417,171	Wall plaque, unglazed earthenware (orangeware), molded relief decoration, micaceous slip
USNM 417,174	*Kūzā*, water pitcher, unglazed earthenware (orangeware), part-molded relief decoration, pierced, with red, white and black pigments (Plate 42*c*)

ALAM GANJ (SWAT, NWFP)

1971

POTTER AMIR

USNM 417,317-A	Teapot, for boiling tea; unglazed earthenware
USNM 417,318-A, B	Cooking pot (A) with lid (B) for cooking rice; unglazed earthenware; black pigment brushwork decoration
USNM 417,319	Dish for cooking *capātī* (bread); incised and combed decoration (Plate 20*a*); similar to USNM 412,691-A, B
USNM 417,320	Dish, for serving rice; unglazed earthenware
USNM 417,321	Coarse sand, mixed with clay for red earthenware body (Table 8)
USNM 417,322	Fine sand, mixed with clay for red earthenware body (Table 8)
USNM 417,323	Clay, mixed with either fine or coarse sand for body (Tables 6, 7)
USNM 417,324	Red slip, raw material to be crushed and mixed with water for application; for unglazed earthenware
USNM 417,325	Black pigment; raw material to be crushed and mixed with water for brushwork decoration (analysis, Table 9)

BAHAWALPUR (PANJAB)

1971

Khār PRODUCER
MIAN ALLAH BAKSH

USNM 417,176	*Haloxylon recurvum* from Cholistan Desert; sintered plant ash *(cūā khār)*, "first grade," uniform light color, porous (Plate 74*c*)
USNM 417,177	*Haloxylon recurvum* from Cholistan Desert; sintered plant ash *(rotā khār)*, "second grade," streaked with reddish color
USNM 417,178	*Haloxylon recurvum* from Cholistan Desert; sintered plant ash (*khār*), "third grade," dark color, greenish, charcoal common, dense

POTTER NOT RECORDED

USNM 417,179-A–F	Oil lamps, unglazed earthenware, various sizes
USNM 417,180	Cooking pot stand, unglazed earthenware, modeled decoration and red slip (Plate 49*b*)
USNM 417,182-A–D	Foot scrapers, shoe cleaners, unglazed earthenware, thrown and modeled, rough textured scraping surfaces (Plate 49*c*)
USNM 417,593–A, B	Plant sample (*Haloxylon recurvum*), stem and upper part of *khār* bush; collected in Cholistan Desert ca. 24 km E of Bahawalpur city in October, before flowering season (Plate 74*a*)

BOMBORET (KAFIRISTAN, NWFP)

1971

POTTER NOOR KHAN

USNM 417,522	Clay, mixed with crushed quartz for red earthenware body (Tables 6, 7)
USNM 417,523	Quartz stone, crushed and mixed with clay for red earthenware body
USNM 417,524	Water pot made to demonstrate techniques of forming and firing (Plates 3, 4, 5, 6)
USNM 417,525	Pine wood (*Pinus excelsa*), fuel used for pit-kiln (Table 5)

DEOLAI (SWAT, NWFP)

1968–1969

POTTER NOT RECORDED

USNM 412,686	Butter churn (*cātī*), unglazed earthenware; incised and applied decoration, black brushwork decoration (Plate 20*d,e*)
USNM 412,691-A, B	Dishes for cooking *capātī* (bread), A has been used, blacked, B is unused; both unglazed earthenware (similar to the dish shown in Plate 20*a*)

DERA ISMAIL KHAN (NWFP)

1971

POTTER MAHOMMED JAN

USNM 417,233	Clay used without admixture for body for unglazed eathenware (Tables 6, 7)
USNM 417,234	Sand used in slip coating for unglazed earthenware; mixed with clay and salt
USNM 417,235	Raw material for red slip
USNM 417,236	Pigment, used for brushwork decoration; two samples, a red and a black pigment (for latter see Table 9)
USNM 417,237	Mechanism of potter's pit-wheel (Plate 33*c*, wheel before removal; Figure 3, relationship of components); all made of wood

Tanur-MAKER

USNM 417,239	Clay, used in *tanur* body (mixed with sand, vegetable fibers, sintered plant ash, donkey dung, salt and water)
USNM 417,240	Sand, used in *tanur* body (mixed with clay, vegetable fiber, sintered plant ash, donkey dung, salt and water)
USNM 417,241	Sintered plant ash (*khār*), used in *tanur* body (mixed with clay, sand, vegetable fiber, donkey dung, salt, water)
USNM 417,242	Chopped vegetable fibers (*munj*, from *Saccharum munja*), used in *tanur* body (mixed with clay, sand, sintered plant ash, donkey dung, salt, water)

DIR (NWFP)

1971

POTTER KHAN ZADA

Field 71–1 **	Raw material for red slip, for application on unglazed ware
Field 71–2 **	Black pigment for brushwork decoration of unglazed ware
Field 71–3 **	Sand, used in clay preparation and for addition to clay body
Field 71–4 **	Sandy clay mixed with fine clay and sand for body
Field 71–5 **	Fine clay mixed with sandy clay and sand for body
Field 71–13 **	Washbasin, unglazed red earthenware
USNM 417,380	Paddle, used in forming base of round-bottomed vessels; wooden (Plate 79*a*)
USNM 417,381	Anvil, used with beater for forming base of round-bottomed vessels; fired clay (Plate 80*b*)

USNM 417,382 — Smoothing tool, used to smooth the upper walls of vessels while forming by throwing; double ended; wooden (Plate 79*e*)

USNM 417,383 — Smoothing tool, used to smooth upper walls of vessels while forming by throwing; single ended, wooden (Plate 79*f*)

USNM 417,384 — Smoothing tool, used to smooth upper walls of vessels while forming by throwing; single ended, wooden (Plate 79*d*)

USNM 417,609 — Sieve, used for sieving clay during body preparation (Plate 13*a*); wooden frame, pierced leather attached to frame with leather thong (Plate 12*a*)

USNM 417,610 — Sieve, used for sieving sand used in body preparation (Plate 13*b*); wooden frame, pierced leather attached to frame with leather thong (Plate 12*b*)

GARHI MAQBULABAD (GUJRAT, PANJAB)

1971

Potter Sardar Mahommed

USNM 417,246-A–F — Six *topī* (tobacco bowls) for cilam (hookah or water pipe); unglazed earthenware, red slip (Plate 35*a*)

USNM 417,247-A, B — Bowl, unglazed earthenware, red slip, very thin-walled (Plate 37*d*)

USNM 417,248 — Clay, mixed with sand for unglazed earthenware body (analysis, Tables 6, 7)

USNM 417,249 — Sand, mixed with clay for unglazed earthenware body (analysis, Table 8)

USNM 417,250 — Slip clay; yellow color, mixed with water and applied to unglazed earthenware vessels as a slip, fires red (analysis, Table 6)

USNM 417,251 — Bowls, "industrial" manufacture; white body, stenciled decorations, lead glazed

HALA (SIND)

1967–1968

Potter Not Recorded

USNM 410,486 — Frit, in crucible; block of frit formed by mixing finely ground soda ash (sodium carbonate, Na_2CO_3) and flint (each 50% by weight) and fusing in kiln; greenish white, transparent frit; crushed and used as glaze (analysis, Tables 12, 13)

USNM 410,487 — Flint; described by collectors as "natural flint for use in making glaze" (cf discussion of Hala glaze making, p. 109 herein); flint crushed and used as siliceous slip for alkaline glazed ware

USNM 410,488 — Calcined flint, described by collectors as "used in glaze making" (*but for slip for alkaline glazed ware?*); calcined to facilitate crushing and grinding

USNM 410,489 — Slip clay; white clay, basis for white and colored slips for lead glazed ware

USNM 410,491 — Two identical tiles; white siliceous slip on pinkish body, blue, turquoise and green brushwork, clear alkaline glaze (Plate 77*e*)

USNM 410,492 — Tile, perforated (screen tile); white siliceous slip, cobalt blue brushwork decoration; turquoise alkaline glaze (Plate 77*d*, Tables 12, 13)

USNM 410,493 — Body clay; used without admixture for tile body (Tables 6, 7)

1971

Potter Shafi Mahommed

USNM 417,113-A, B — Dish (A) with lid (B); white slip, pink and brown slip brushwork decoration, amber lead glaze (Plate 78*d–f;* Tables 12, 13)

USNM 417,114 — Base for large urn; brown slip, white and green slip brushwork decoration, clear lead glaze

USNM 417,115 — Flower pot; white siliceous slip, pink slip brushwork decoration, and blue pigment brushwork; clear alkaline glaze (Plate 77*c*)

USNM 417,117-A, B — Dish (A) with lid (B); brown slip, white and green slip brushwork decoration, clear lead glaze (Plate 78*a,b,c*)

USNM 417,119-A, B — Plates (two), brown slip, white and green pigment brushwork decoration, amber lead glaze (Plate 77*b*)

USNM 417,120 — Large dish, white siliceous slip; blue, turquoise and green brushwork decoration, clear alkaline glaze (Plate 77*a*)

USNM 417,121-A–C — Tiles (three), with white slip, pink and brown slip brushwork decoration, clear lead glaze (Plate 77*f*)

USNM 417,122 — Tile, 12-pointed, white siliceous slip, blue, green, and turquoise brushwork decoration, clear alkaline glaze (Plate 77*g*)

USNM 417,123 — Tile, white siliceous slip, blue, turquoise and green pigment brushwork decoration, clear alkaline glaze

USNM 417,124 — Tile, white siliceous slip, blue and green brushwork decoration, clear alkaline glaze; made in 1927 by father of potter Shafi Mahommed (Tables 12, 13)

USNM 417,125-A, B — Stilts, for setting glazed ware in kiln (Plate 81*n,o*)

USNM 417,126 — Flint, unprepared stone, to be crushed and ground for application as white slip used under alkaline glazes

USNM 417,127 — Clay, used without admixture as body for forming glazed ware and tiles (analysis, Tables 6, 7)

KHARMATHU (NWFP)

1971

Potter Sher Zaman, brothers

USNM 417,540	Clay mixed with sand and salt (NaCl) for body (Tables 6, 7)
USNM 417,541	Sand mixed with clay and salt (NaCl) for body (Table 8)

MADAK (CHITRAL, NWFP)

1971

Potter Not Recorded

USNM 417,413	Milk pitcher, globular body, flat based, with spout and vertical handle; made at summer palace (Plate 11*b*)

MULTAN (PANJAB)

1967–1968

Potter Not Recorded

Field 71–430 **	Quartzite (*karunḍ*), crushed and ground in stone quern, powder ready to mix with powdered *khār* (plant ash) as first stage of alkaline glaze preparation
USNM 410,665-A	*Khār*, sintered plant ash, described by collectors as: "slag resulting from burning of *suji* (sic) plant, and subsequent refining in water"
USNM 410,665-B	Described by collectors as: "Potash crystals, refined from *khār* by dissolving *khār* in water, pouring off water, evaporating; crystals form on evaporation"; subsequently identified as aphthitalite (potassium sodium sulphate, $K_3Na(SO_4)_2$): said to be used in glaze-making
USNM 410,665-C	Quartzite (*karunḍ*): used as ingredient of alkaline glaze
USNM 410,665-D	Ball of mixed *khār* and *karunḍ* powders; to be fused to form frit for glaze: cf USNM 410,665-A and USNM 410,665-C
USNM 410,665-E	Frit; fused mixture of *khār* (plant ash) and *karunḍ* (quartzite); greenish white glass; *final* frit; to be crushed and used as glaze; sample has been removed from crucible (Tables 12, 13)
USNM 410,665-F	Glaze, crushed and ground, ready to mix with flour/water glue for application. Same material as USNM 410,665-E
USNM 410,665-H	Described by collectors as "litharge sample, made by melting lead and scooping off the oxide; for colored slips"
USNM 410,666	Bottle vase, with white siliceous slip and brushwork pigment of copper and cobalt decoration applied, but unglazed and unfired
USNM 410,667	Bottle vase, similar to USNM 410,666, white siliceous slip, brushwork decoration completed but unglazed and unfired
USNM 410,668	Tile, white siliceous slip, black outline for floral decoration; unglazed and unfired partially decorated
USNM 410,669	Small dish, white alkaline slip, blue and turquoise brushwork decoration, clear alkaline glaze; diameter ca. 20 cm, height ca. 4 cm
USNM 410,670	Plate, red earthenware body, white siliceous slip, blue and turquoise brushwork decoration, clear alkaline glaze; diameter 25.3 cm, height 4.3 cm
USNM 410,671	Dish, red earthenware body with white siliceous slip, blue and turquoise brushwork decoration, clear alkaline glaze (underfired); diameter 23.5 cm, height 7.6 cm
USNM 410,672	Bottle-vase, white siliceous slip, blue and turquoise brushwork decoration, clear alkaline glaze (Plate 75*d*)

1971

Master Potter Khuda Baksh

USNM 417,187-A–F	Six tiles, white siliceous slip, blue brushwork decoration, clear alkaline glaze, geometric pattern ca. 15 cm square
USNM 417,188-A	Tile, white siliceous slip, blue and turquoise brushwork decoration including calligraphy: "Allah," ca. 23 cm square
USNM 417,189	Flower vase, white siliceous slip, blue and turquoise brushwork decoration
USNM 417,190	Large dish, white siliceous slip, blue and turquoise brushwork decoration on interior (upper) surface, clear alkaline glaze: "Flower-circle" decoration. USNM 417,191 is identical (Plate 75*a*, Tables 12, 13)
USNM 417,192	Large dish, white siliceous slip, blue and turquoise brushwork decoration on interior (upper) surface, clear alkaline glaze: "Four-section" decoration (Plate 75*b*)
USNM 417,193-A, B	Two dishes: white siliceous slip, blue and turquoise brushwork decoration on interior (upper) surface: underfired alkaline glaze (Plate 75*c*, Tables 12 and 13)
USNM 417,194-A	Tomb plaque gravestone; white siliceous slip, recessed central panel, with calligraphy in blue; blue and turquoise brushwork decoration, clear alkaline glaze (Plate 76)
USNM 417,195	Sand, to be mixed with clay for body, Multan glazed ware (analysis, Table 8)

USNM 417,196 Borax (sodium borate, $Na_2B_4O_7 \cdot 10H_2O$), *sohāgā*, for addition to glaze frit before second fusion of frit

USNM 417,197 Copper scale; pigment for turquoise colored brushwork decoration, applied over siliceous slip (underglaze) (analysis, Table 9)

USNM 417,198 Siliceous slip (*astar*), in powder form, ready to mix with flour/water glue for application to glazed ware

USNM 417,199 Fused balls, formed by mixing powdered quartzite and powdered sintered plant ash (*khār*), moistening the powder slightly, and then pressing by hand into balls, then fusing these in the kiln firebox (Plate 74*d,e*)

USNM 417,201 Ground glass cullet; powder said to be added to glaze batch by some Multan potters

USNM 417,202 Alkaline glaze (*kac*), powder ground, ready to mix with flour/water glue for application to slipped and brushwork decorated vessels (analysis, Tables 12, 13)

USNM 417,203 Sintered plant ash (*khār*), crushed and ground to powder, ready to mix with powdered quartzite as first stage of alkaline glaze preparation

USNM 417,204 Balls, formed by mixing powdered quartzite and powdered sintered plant ash (*khār*) moistening the powder slightly and then pressing by hand. Dried but unfired; cf USNM 417,199

USNM 417,205 Clay, to be mixed with sand for body, Multan glazed ware (analysis, Tables 6, 7)

USNM 417,589 Unfired body, clay and sand mixed, used for forming glazed ware

USNM 417,590 Sintered plant ash (*Khār*), rock-like pieces of material in the form in which it is purchased by potters (Plate 74*b*)

USNM 417,591 Quartzite; large pieces of stone brought by Multan potters from deposit at Sakhi Sarwar before any preparation of glaze

USNM 417,592 Fuel wood pieces of the fuel (*Populus euphratica?*) used in updraft kiln for glazed ware

NURAR (BANNU, NWFP)

1968–1969

Potter Not Recorded

USNM 412,568 Water carrying flask (pilgrim flask), unglazed earthenware with white slip; lugs on shoulder for rope-slings; footring on base allows standing on flat surfaces, or stacking (Plate 32*d,e*)

USNM 412,569 As USNM 412,568, smaller size

USNM 412,570 Rice husking mill, unglazed earthenware, incised and impressed decoration on upper surface, red slip; pyramidal indentations on lower grinding surface (Plate 32*a–c*)

USNM 412,571 Slip clay, mixed with water for white slip, for unglazed ware

USNM 412,572 Slip clay, mixed with water for application as red slip

USNM 412,573 Sand, mixed with clay for body for unglazed ware

PABBI (NWFP)

1971

Potter Not Recorded

USNM 417,308-A–F Six bowls, decorated with white slip brushwork, lead glazed on interior (Plate 68*a, c–e*, Tables 12, 13)

USNM 417,309-A–D Setters (props) used for setting glazed ware in kiln for firing (Plate 81*e–h*)

USNM 417,310-A, B Stilts, three pointed, used in conjunction with props for setting glazed ware for firing (Plate 81*l, m*)

USNM 417,311 Clay, mixed with sand for glazed ware body (clay 66%, sand 33%) (analysis, Tables 6, 7)

USNM 417,312 Sand, mixed with clay for glazed ware body (clay 66%, sand 33%) (analysis, Table 8)

QUETTA (BALUCHISTAN)

1969–1970

Potter Not Recorded

USNM 414,542 Urn, with two handles on shoulder, green glaze over brown slip; impressed decoration around rim; used for storing pickles, oil and *ghī* (butter) (Plate 54*b*, Tables 12, 13)

USNM 414,544 Small urn, with two handles on shoulder, brown glaze over brown slip, impressed decoration around rim (Plate 54*c*)

USNM 414,546-A Water jar (*surāhī*), mold formed in two-part mold with relief decoration from mold; neck and foot thrown and joined after molding; red slip on shoulder (Plate 53*a*)

USNM 414,546-B Water jar (*surāhī*), mold formed in two-part mold, with relief decoration from mold; neck and foot thrown and joined after molding; red slip on shoulder (Plate 53*b*)

USNM 414,547 Hookah (*cilam*) base, dark brown glaze over brown slip; pale body color; tobacco bowl attaches at top of neck, stem of pipe at side of neck (Plate 54*a*, Tables 12, 13)

USNM 414,548 Pitcher, with spout and handle at shoulder, unglazed; height, ca. 15 cm, diameter, ca. 12 cm (children's toy?)

USNM 414,549 Bowl (*piālā*) with turned footring, glazed on interior and upper outer walls with dark brown glaze; height ca. 10 cm, diameter ca. 20 cm

USNM 414,550-A, B Two identical oil lamps, unglazed, wheel thrown with a finger-formed spout for the wick; height ca. 3.6 cm, width less than 7 cm

USNM 414,551 Footscraper or callus remover, unglazed, with two rough-textured flat sides and knobbed handle (Plate 49*d,e*)

USNM 414,552-A, B Milk vessel (A) with lid (B); unglazed, black brushwork decoration on shoulder, round-bottomed, used for heating milk; height, ca. 19 cm, diameter, ca. 28.5 cm

USNM 414,553 Claystone or mudstone from Sind, ground and mixed with water and applied to vessels as a brown slip (Table 6)

USNM 414,554 Glass cullet, ground by potters for incorporation in glaze batch

USNM 414,555 "Red lead"; lead oxide, for incorporation in glaze batch

USNM 414,556 Brown powder described by collectors as "crushed inner portion of dry cell batteries"; used as colorant in brown glaze (Table 9)

USNM 414,557 Copper scale, used by potter as colorant for green glaze (Table 9)

USNM 414,558 White powder, described by collectors as "borax" (*sohāga*), for incorporation in glaze batch

USNM 414,559 Black pigment, raw material (stone); crushed and mixed with water by potter for brushwork decoration of unglazed ware

USNM 414,560 Stilt, unglazed earthenware, for setting glazed ware in kiln (Plate 81*i*)

USNM 414,561-A–C Setters (props), unglazed earthenware, for setting glazed ware in kiln (Plate 81*a–c*)

USNM 414,562 Clay, used without admixture as body for glazed and unglazed ware. Described by collectors as "limestone silt"

USNM 414,563 "Bird's nest," earthenware; placed inside a closed room for pet birds; diameter ca. 13 cm, height ca. 16 cm

1971

POTTER NOT RECORDED

USNM 417,183-A, B Stilts, for setting glazed ware in updraft kiln (Plate 81*j,k*)

USNM 417,184 Prop, for use in conjunction with stilts in setting glazed ware in kiln (Plate 81*d*)

USNM 417,185 Hookah base (*cilam*), dark brown glaze over brown slip (similar to USNM 414,547 on Plate 54*a*)

SEEN (CHITRAL, NWFP)

1971

POTTER MEHRAB SHAH

USNM 417,417 Milk pitcher (Plates 10, 11*a*)

USNM 417,418 Willow hoop, used in forming round-bottomed vessels (Plates 7*a*, 8)

USNM 417,419-A, B Paddles, used in conjunction with anvil for forming round-bottomed vessels, wood (Plates 8, 9, 79*b,c*)

USNM 417,420 Anvil of a river pebble, used in conjunction with paddles for forming round-bottomed vessels (Plates 8, 9, 80*d*)

USNM 417,421 Clay, used without admixture for red earthenware body (Tables 6, 7)

SHADIWAL (GUJRAT, PANJAB)

1971

POTTER NOT RECORDED

USNM 417,252-A–C Three dishes; unglazed earthenware, red slip, black pigment brushwork decoration (Plate 40)

SHAHBAZ AHMED KHEL (BANNU, NWFP)

1971

POTTER MIR SHAD

USNM 417,268 Water pitcher (*kūzā*); unglazed earthenware; overfired, exhibiting squatting and distortion due to excessive vitrification (Plate 82*a*)

USNM 417,269 Clay; mixed with sand for body (Tables 6, 7)

USNM 417,270 Sand; mixed with clay for body (Table 8)

USNM 417,271 Clay, raw material for red slip; mixed with water for application on unglazed earthenware

SHAHDERI (PANJAB)

1968–1969

POTTER NOT RECORDED

USNM 412,503 Sintered plant ash (*ashgār*), origin unknown but related to *khār* samples; this particular sample collected from leather workers who use it in the tanning process

SWAT (NWFP)

1971

POTTER NOT RECORDED

USNM 417,374 Cooking pot stand with modeled decoration (Plate 49*a*)

THATTA (SIND)

1967–1968

POTTER NOT RECORDED

USNM 410,474 Tile fragment, age unknown, red body with white slip, blue brushwork decoration, alkaline glaze. From stockpile being used to restore Shahi mosque (USNM 410,475 is similar)

USNM 410,475 Tile sample, section of thick pottery tile set in wall platers; blue and white glazed, calligraphic design

ZAKHEL BALA (NWFP)

1968–1969

POTTER NOT RECORDED

USNM 412,410 Water jar, unglazed earthenware, formed in two-piece mold; upper mold with impressed decoration hence relief decoration on vessel; neck thrown (cf Plates 23 and 24); red slip decoration on upper walls (Plate 66*a*)

USNM 412,411 Water pitcher (*kūzā*) with spout, unglazed earthenware; incised bands on shoulder, spouted red slip overall (Plate 66*b*)

USNM 412,412-A, B Cooking pot (A) with lid (B), unglazed earthenware, mold-formed base, incised and impressed patterns, red slip, black pigment brushwork (Plate 66*c*)

USNM 412,413 Plate, dark brown glaze, incised decoration on rim, turned foot-ring; diameter 18.5 cm, height, 2.6 cm

USNM 412,414 Ash (wood ash?), used to dust surfaces on which clay body is kneaded

USNM 412,415 Sand; for use in preparation of clay body (analysis, Table 8)

USNM 412,416 Top half of mold for *mangay,* unfired earthenware, impressed decorations. Bottom half of mold was collected in 1971 (Plate 67)

POTTER ROSHAN DIN, BROTHERS

USNM 412,417 Anvil, fired clay, used by potters to smooth interior of mold-formed vessels on wheel; not used with paddles (Plate 80*a*)

POTTER NOT RECORDED

USNM 412,418 Turning tool, sheet-steel strip, used for turning leather-hard vessels (Plate 58*a,b*)

USNM 412,419 Smoothing tool, wood; used in forming operations (Plate 79g)

USNM 412,420 Scraping tool, steel, normally used by matmakers in weaving *mazrī* fiber matting, but adapted by potters as a scraping tool

USNM 412,456 Clay for earthenware body (unglazed and glazed ware); sand (USNM 412,415) added during body preparation (Tables 6, 7)

USNM 412,457 Clay for white slip used on glazed ware; light gray color

USNM 412,458 Slip clay, mixed in water, the suspension used as red slip for unglazed earthenware

USNM 412,459 Quartzose stone, to be mixed with lead oxide and fused to form glaze frit

USNM 412,460 Crushed glaze, quartz and lead oxide frit, to be ground for application before glaze-firing

USNM 412,461 Brown/black pigment, raw material to be crushed and mixed with water for brushwork decoration (analysis, Table 9)

USNM 412,462 Pigment, copper scale, used for green brushwork decoration on glazed ware (underglaze) and as green colorant in lead glazes (analysis, Table 9)

USNM 412,463 Pigment, used for blue brushwork decoration on glazed ware (underglaze) (analysis, Table 9)

USNM 412,464-A, B Hookah base (*cilam*) (A), incised decoration, white slip, green and brown brushwork decoration under clear glaze, height 33 cm, maximium diameter 12 cm; tobacco bowl for hemp (B), similar decoration to A, height 9 cm, maximum diameter 5.7 cm

USNM 412,465 Hookah base (*cilam*), unglazed earthenware, incised decoration

USNM 412,466 Bowl, with white slip, blue and brown pigment brushwork decoration, clear glaze on interior, undecorated and unglazed on exterior, turned foot (Plate 68*b*, Tables 12, 13)

USNM 412,467 Bowl, unglazed earthenware, decorated on interior with black pigment brushwork; for mixing flour to ferment before making *nan;* diameter 36.5 cm

USNM 412,468 Rice dish, unglazed earthenware, diameter, 38.5 cm

USNM 412,469 Bowl, unglazed earthenware, diameter 38.5 cm, height, 17 cm

1971

POTTER ROSHAN DIN, BROTHERS

USNM 417,313 Hookah (*cilam*) base, green (copper) lead glaze on earthenware body, incised decoration, white slip; has been overfired: neck broken, bloating evident on one side; copper-red color glaze on one side as a result of localized reduction, glaze green elsewhere (Plate 82*b*, Tables 12, 13)

POTTER NOT RECORDED

USNM 417,314	Building mud; used in kiln construction as insulating material, and mortar; also used for housing construction in local villages

POTTER ROSHAN DIN, BROTHERS

USNM 417,315	Clay; used for earthenware body, without admixture (Tables 6, 7)
USNM 417,316	Clay, for white slip, purchased from Gujrat, Panjab; used also as fire-clay in kiln construction
USNM 417,317	Stone, quartzose sandstone(?) friable, mixed with lead oxide, then both fused to form glaze frit

Appendix 2

A MULTAN MASTER POTTER'S DESCRIPTION OF POTTERY MAKING

Owen S. Rye

During the 1971 field studies in Pakistan, the writer spent a total of one week at the workshop of the master potter Khuda Baksh of Multan. The observations and discussions from this period are reported in detail in the main body of this work.

At one point through the week, we reached a stage where I was quite confused about the glaze-preparation process in Multan. This situation arose because Khuda Baksh had begun to explain some of the variations in methods used by other potters he knew in Multan, and somewhere in the process of explanation to the interpreter and interpretation to the investigator we lost communication. As a result Khuda Baksh said that he would write down the basic processes to insure that I understood them properly; then we could discuss the variations in these processes with a little more assurance. The following document is the result. The initial translation from Multani (Panjabi script) was made by Mahsood Ahmed Siddiqi in Pakistan. This translation was later checked by Dr. C. Shackle of the School of Oriental and African Studies, London University, and I thank both of them for their assistance.

A Description of Pottery Making *(Kāshīgari)* by Khuda Baksh, Multan

1. Formula for Glaze No. 1.—Having beaten one seer of *karunḍ* [quartzite] and also pounded one seer of *khār* [sintered plant ash], make a dry mix of both of these substances. Then put both of them in a *thāl* (tray). After doing the mix pour in water. A dry powder will form. Then make balls of this powder. Dry these balls in the sun for fifteen days. After they have been dried, put the balls in the kiln at the same time as you close up the fire of the kiln. Close up the opening of the kiln with bricks. After three or four days the kiln will be cold. Then take out the balls and pound them with an iron mortar *(imām-dastā)*. Then, having beaten two *chitānk* of borax (*sohāgā*), add this too to the balls. Then fill up crucibles (*daurī*) with them. Then again, put these crucibles in just the place where the fire of the kiln is at its maximum. After the kiln has cooled, take out the crucibles. Then beat them and grind very fine in the quern (*cakkī*). This is the No. 1 glaze which will be ready. We call it [literally "them"] "*kac* no. 1" in the Multani language. This is a glaze for applying on top of the clay.

2. We call that which is applied on top of the clay *astar* in the Multani language. The formula is: one seer *karunḍ* stone, one seer *kac* no. 1. These should be beaten in the *imām-dastā* separately. Only *karunḍ* stone powder is placed in the sun and dried. Then these two powders should be mixed together and ground in the *cakkī* as fine as one can do. Then the *astar*, which is for applying underneath, will be prepared.

3. Method of Application.—One seer of astar=1½ chitank (3 parts) *maida* (finest wheat flour)+¾ seer *pāni* (water)—24 parts. This is cooked on a fire. When you find thread in it, then you should note that the *levī* (glue) is ready. The method of application of *kac* no. 1 and *astar* is one and the same. Both are applied in the same way.

4. How the Bartām (Pots) Are Set in the Kiln.—The pots should be placed in the *bhaṭṭī* (kiln) leaving sufficient space and not congested so that they should not touch each other. After placing the pots in the *bhaṭṭī*, the *darī* (main door) should be closed, so that the heat will not be wasted by throwing it out. Then the smoke holes on top of the *bhaṭṭī* should be opened so that the smoke comes out. Then light the fire from underneath.

5. Method of Firing.—In the beginning the fire should be kept very light. If you make it burn too fiercely, the pots will crack. When the walls of the kiln become a little warm, then put your hand over the smoke hole on top. When your hand starts to burn, then increase the fire. When the fire part of the kiln looks red, then make it still hotter. Then, when the pot part of the kiln becomes red, then gradually decrease the fire a bit. When the color of the pots and the fire start to remain the same, flames will come out of the smoke holes on top. Then there will be flames of four colors. These are the colors of the flames: green, blue, red, white. Then, with the fire decreased, the green and red flames will stop. When flames of this color—blue and white—appear, then close up the fire, so that the gas of the fire does not escape.

Khuda Baksh—written by his own hands.
Lohāri Gate, Kutcheri Road, Multan.

Appendix 3

KHĀR: SINTERED PLANT ASH IN PAKISTAN

Owen S. Rye

Introduction

In the section of this work where glaze making in Multan has been discussed (pp. 94–98), and in subsequent discussion of glazes (p. 139), the use of plant ash as a glaze ingredient has been noted. Plant ash is also used in the preparation of some *tanur* bodies (bread ovens).

The use of plant ash in glass and glaze making has been extensively documented in the literature. Unfortunately there is no single publication to bring together and summarize all that is presently known about such uses of plant ash. Such a publication would be of considerable value to many workers in this field.

Plant ash has long been used in many parts of the world as a source of alkali (sodium and potassium compounds); the technology of some processes has great antiquity. In ancient Mesopotamia (Levey, 1959), plant ashes were used in the production of soaps or detergents, and in medicinal preparations. Levey noted that one of the commonly used plants (*Salsola kali*) has been a source of alkali for more than 5000 years, as it is still in use in some areas of the Middle East. The Mesopotamian's knowledge of variations in the ash of different plants was apparently quite extensive; a variety of plants were reduced to ashes and different types of ash were selectively used for quite distinct purposes. Forbes (1957:117–237) makes numerous direct or oblique references to the use of alkaline ash in ancient glasses and glazes and provided a lengthy bibliography.

Plant ash is still being used as an alkali source in countries ranging from Pakistan and Indian and including Lebanon and Syria. Any traveler in Pakistan or Afghanistan can see the rock-like blocks of *khār* or *ashgār* on sale in the bazaars. Most of these are used by villagers as a substitute for soap.

As in Mesopotamia, so recently in India and Pakistan, a variety of plants have been burned to produce ash for various purposes. Hooper (1912) discussed the use of the ash from plantain (*Musa sapientum*) leaves and stalks by dyers as an alkaline mordant by *dhobi* (washermen) in place of soap in medicinal preparations as a crude form of table salt, and as fertilizer on the fields. He referred to the preparation of *"khār-pani"* (sic), formed by soaking the ash in water; dyed fabrics were immersed in this to fix the dye. Apart from plantain, other plants used for this purpose were *Acyranthes aspera, Boerhaavia diffusa, Gmelina arborea,* and *Vitex trifolia.*

In the context of glass and glaze making it is impossible to summarize the literature in the short space available here. Plant ash has long been used in the high temperature (up to 1350°C) stoneware and porcelain glazes of China and Japan (Brinkley, 1904; Burton, 1906; Cardew, 1969; Furnival, 1904; Garner, 1954; Hetherington, 1937; Leach, 1945; Ling, 1941; Rye, 1970; Sanders, 1967). The type of ash used in this context contributed primarily calcium, sodium-potassium, and to a lesser extent, silicon and phosphorous to the glaze batch.

As a slight digression, it may also be noted that ash obtained by calcining bones has played a significant role in the development of modern English industrial ceramics (Rye, 1970, for bibliography).

The excellent series of papers by Turner (1954a; 1954b; 1956a; 1956b; 1956c) summarize much of the knowledge of the use of plant ash in glass compositions in antiquity. The recent work of Brill (1970) contributes significantly to our knowledge of the technology of Mesopotamian glass making. Brill experimentally produced glass batches from mixtures of plant ash and quartzite. Research reported in the section on glazes in the present work (pp. 143–144), in which studies of the fusibility of plant ash/quartzite mixtures are reported, produced results comparable with those reported by Brill.

Apart from the need, mentioned above, to bring

together in one volume the present knowledge of the use of plant ash in glass and glazes, it is desirable that differentiation be made between plant ash types on the basis of composition. It may be inferred from the literature that three major groups occur. One, those ashes which have a high K_2O content relative to Na_2O; secondly those which have the reverse, a high Na_2O content relative to K_2O; thirdly those which have variable K/Na content but a high Ca/Mg content. Silica and phosphorus contents of the three groups may provide further classifications. The second group is derived from the burning of plants from alkaline desert regions; the first and third groups from normal land plants (trees, bushes, grass, straw, etc.) in fertile regions. Developments in glass and glaze making in the ancient (e.g., Mesopotamian) and recent (Islamic) contexts in the Middle East have been based on plant ashes in the second group, with an Na_2O content higher than K_2O, derived from the burning of plants which grow in alkaline desert or desert-fringe areas. Other developments, such as glass making in Medieval Europe, and high-temperature glazing in China and Japan, were based on the ashes of plants from fertile regions.

Leaving aside all except developments in the ancient and modern Middle and Far Eastern regions, same aspects of glazing can be summarized. One problem in archeology for some time has been to explain the technology of Egyptian faience: blue-glazed beads or other objects, with the body consisting primarily of crushed quartz. Lucas (1962:160) speculated that plant ash could have been used in the production of the glaze on this type of ware, but it remained for this speculation to be finally proved feasible and probable by H. Wulff (Wulff, Wulff, and Koch, 1968). Wulff had earlier (Wulff, 1966) outlined the techniques of preparation and use of plant ash in conventional Islamic alkaline glazes in Iran (Persia). In the later paper, published after his death, Wulff described the use of plant ash in glazing blue beads from Qom, Iran, in a process which he held to be probably very similar to that used to produce ancient Egyptian faience. His experiments on the production of the blue glazed beads showed that he could reproduce them under controlled conditions, using materials obtained from the faience makers of Qom. The plant ash, *oshnan*, was derived from *Salsola kali* or *Salsola soda*.

The plants known as *oshnan* or *ushnān* are mentioned in the well-known writings of Abū'l-Qāsim (two manuscripts dated 700AH/1301AD and 991 AH/1583AD), which have been available in German translation since 1935, but have only recently been fully translated into English (Allan, 1973:112). In a list of basic materials for use in *kāshī-garī*:

> The fifth is *shakhār*, which they call *qalī*, which is made by burning pure, fully-grown *ushnān* plants, not mixed with *shūreh*, which is like *ushnān*. [If it is "mixed with *shūreh*," it makes it rotten.] The best *shakhār* is that which has a red-coloured centre when broken, with a strong smell. *Ushnān* is found everywhere. . . .

This ash was fritted with quartz during glaze preparation. The proportions of ash and quartz used in the frit batch varied according to the quality of the *shakhār* (from one part ash, one part quartz for the best ash, to one and a half parts ash to one part quartz for the worst quality ash). This fits well with the outline given by Khuda Baksh for the first stages of glaze making in Multan (Appendix 2, and pp. 94–95).

The literature sources for a study of glaze-making techniques in Pakistan (and India) are not numerous. The best English-language sources are those of Baden-Powell (1872) and Halifax (1892). Birdwood (1880) has also discussed glaze making, but his information seems to have been wholly derived from the earlier work of Baden-Powell and is, therefore, redundant.

Baden-Powell (1872:221) and Halifax (1892:17) both refer to the use of two different types of "kanch" used in glaze preparation. This term "kanch," which they use synonymously with "glass," should really be translated as "frit" in the context in which it is applied; the term refers to a glassy substance, but it was apparently used only as an intermediate step in the preparation of glaze.

One of the frits was known as "English kanch"; this was based on a quartzose rock, pure soda (Na_2CO_3), purified borax, and sal-ammoniac, according to Baden-Powell (1872:221). The other type, "native kanch," was reported by the writers in various forms. Baden-Powell (1872:221) referred to "desi-kanch," which was "made either out of *reh*, or alkali earth, with sand, i.e., a natural efflorescent alkali and fine siliceous sand; or with ground stone and potash, or with stone, borax and sand."

In this quotation there is a reference to *reh*, which presumably is the natural alkali more widely known as "natron." It is confusing to attempt to interpret what is meant by the last-mentioned mixture of "stone, borax and sand." If "stone" was quartzite, then the "sand" would hardly be siliceous. Possibly this is an oblique reference to the use of plant ash, which, in the sintered form, is stone or rock-like (Plate 74). If so, this would read "plant ash, borax and sand," which would be a reasonable blend of materials from which to produce a frit.

This oblique reference, which could equally be

said to not be a reference at all to plant ash, is the only hint in the literature of the use of plant ash in glazes in Pakistan or India. Lead frits are directly referred to by both Baden-Powell (1872:221) and Halifax (1892:17), and it is clear that a variety of glaze compositions were obtained by roasting lead to different oxidation states and then using the oxides to make frits.

Essentially, then, there is no reference known to this writer that specifically mentions the use of plant ash in glazes in India or Pakistan. This is surprising even when the nature of the investigations made by the English writers is considered. These writers were essentially preparing reports which were to be used for commercial exploitation of the resources of the subcontinent. Much of their information was obtained, not by direct conversations with the craftsmen in their own workshops, but indirectly through the English administrative structure. Baden-Powell's data, which is the most thorough, was primarily obtained from a pamphlet published at the Central Jail, Lahore. The English attempted to introduce a glazed pottery industry in various jails in India, and it is not unlikely that the working techniques in these situations were heavily influenced by the advice of the English themselves. The same comment would apply to the short-lived "Schools of Art" such as the Bombay School of Art, which were an attempt to structure the local crafts in a commercially acceptable Anglicized form.

Thus, it is not completely surprising that the English writings of the nineteenth century add nothing to the knowledge of plant ash use in glazes, although they do contain useful outlines of other aspects of the pottery craft.

The use of plant ash as a source of alkali has been discussed primarily in botanical literature. Parker (1918) referred to the following plants: *Haloxylon recurvum* (1918:418), from the Punjab plains and Salt Range ascending to ca. 760 m, Multan and Sirsa; flowering November-December; apt to be mistaken for *Anabasis setifera;* vernacular name *khār; Suaeda fruticosa* (1918:416), from the plains of the Punjab, flowers September-October, vernacular *lānī, lāna; Salsola foetida,* common on the plains of the Punjab, flowers November-December, vernacular *lāna, gora lāna, lānī.* These three plants, specifically mentioned as having been burned to produce *sajjī* (alkaline ash), are all of the family *Chenopodiaceae.*

Bamber (1916:70) gives *laghme* as a vernacular term for *Haloxylon recurvum.* He also gives *Haloxylon multiflorum,* the Plains and Salt Range to 610 m, and Baluchistan; vernacular *lāna, gora lāna, shori lāna.*

Watt (1890:199) gave the following vernacular terms for *Haloxylon multiflorum: shalme, lāna* (Trans-Indus); *lāna* (Salt Range); *metra lāna, gora lāna* (Bari Doab); *dāna, shori lāna* (Ferozepur); and for *Haloxylon recurvum: laghme* (Trans-Idus); *khār* (Cis-Indus, Panjab); *khāri-lānī* or *kāri-lānī* (Sind). Watt (1890:199) noted that *Haloxylon recurvum* was used in the manufacture of *sajjī-khār,* which was used as medicinal preparations. The use of *Haloxylon* as camel fodder was mentioned by these writers.

At present the rock-like product of burning one or another of these plants is known universally in Pakistan as *khār,* although sometimes the term "*ashgar*" is used synonymously, or the Urdu *sajji.* The process of preparation has been described to me independently by three informants; two of them potters who use *khār* and one of them a *khār*-producer. Vernacular names given for the bush used for burning are for the "best" bush *khār,* for inferior bushes *lānī, lāna* (Bahawalpur, language Urdu, informant *khār*-producer); *lāya* (in Sindhi) and *lāna* or *ukān* (in Multani dialect, informant Multani master potter); *lānrā* (Hindko Punjabi dialect, Dera Ismail Khan, informant potter and *tanur*-maker).

All the plants mentioned have been used to produce ash for "industrial" uses. It is obvious that the connection between botanical names and the vernacular terms used in local areas for plants is complex. As Parker (1918:v) pointed out, it is not possible to derive a botanical identification from a vernacular term alone, without positive identification from a plant specimen. A few of the vernacular names noted above, however, are repeated in various areas; such as variants on the term "*lāna*"; *khār* or variants; and other terms that are similar to the term used by Abū'l-Qāsim, *shūreh.* The term "*ukan,*" reported by a Multani master potter may represent a misconception on his part, as he had not personally witnessed *khār* production. According to Parker (1918:26, 279) "*ukan*" is vernacular for both *Tamarix articulata* and *Wendlendia exserta,* both of which are unlikely to be used as a source of alkaline ash.

The difficulty of establishing which specific plants have been used to produce ash as a source of alkali is obvious. The further difficulty of isolating the types of plant that were burned to produce ash specifically for use in glass or glaze making means that at this point it is not possible to make such a summary. It is possible, though, to make a beginning. During 1971 the writer went from Bahawalpur into the Cholistan Desert, east towards the Indian border. In this desert area, large numbers of plants are burned to produce sintered ash. Plant specimens were collected, and identified by Mian Allah Baksh, govern-

ment contractor for the production of *khār*, as the best plant for use in producing the alkaline ash, *khār*. This plant was subsequently identified by Dr. Dan Nicolson of the Department of Botany, Smithsonian Institution, as *Haloxylon recurvum*. Significantly, many other plants mentioned in the literature as being sources of alkaline ash are grouped in the same plant family as *Haloxylon recurvum*, the family Chenopodaciae.

Production of *Khār*

In Bahawalpur it was possible to obtain further data on the production of *khār* through the cooperation of Mr. Mian Allah Baksh, who provided a full outline of the preparation processes. Unfortunately it was not possible to see the actual production because the area was visited at the wrong time of year.

The area where Baksh worked was within the Cholistan Desert, about 20 miles (32 kilometers) east southeast of Bahawalpur city. Baksh indicated that two distinct types of bush growing in this area were utilized; one was called *lāna*, and gave an inferior quality ash (botanical identification unavailable). The other, called "*khār*" (*Haloxylon recurvum*), gave the best product.

The *khār* bushes were said to grow to about 0. 6 m high and 1.0 to 1.3 m diameter at harvest time, which was during the months November to January. If more rain than normal fell during the flowering period (at the beginning of winter) the ash produced was of poorer quality. The bushes were harvested with an axe by cutting off at the stem, near to ground level, and piling them in heaps for 15 to 20 days to dry in the sun before burning.

The burning was done at any suitable locality in the desert, chosen so bushes had to be carried the minimum distance; thus, sites could vary from year to year. The bushes were burned in pits (*khaḍḍa*) dug in the sand. These pits were about 1.6 m deep and 1.6 to 3.0 m in diameter, dependent on the degree of compaction of the sand (the looser the sand, the larger the diameter to give a stable pit). When the best quality product was required, a small well (*ṛoa*) was dug at the base of the pit. This well was large enough to contain about one maund (about 40 kg) of the product. The well was covered with a mud lid, leaving access to the pit above through a series of holes (*sūrākh*) each about 3 to 4 cm in diameter. The lid (*cāpaṛ*) was plastered over with cow or camel dung in such a way as to leave the holes clear and unobstructed.

When the bushes were to be burned (*jalānā*, Urdu "to burn," or Multani dialect *bhā lāvaṇ*, a small fire was lit at the bottom of the pit (*khaḍḍa lāvaṇ*, "to heat the pit") and layers of bush thrown in successively, so that the material was burned as slowly as possible. More bushes were added only as the fire burned down each time. A liquid (*ras khār*, "liquid *khār*") dripped down into the lower pit or well through the holes in the cover of the lower well. During a day's work it was normal to burn about 10 maunds (400 kg) of bushes, which would produce about one maund (40 kg) of *khār*. When burning was completed for the day, the fire was allowed to die down naturally, and the ash left to cool (*ṭhāraṇ*, "to cool") overnight.

The next morning the rock-like block of *khār* was broken up with a hammer, and the pieces removed from the pit. After the lid had been broken away the better quality material was then removed from the lower pit or well. Then, according to Mian Allah Baksh, the *khār* product was sorted into three grades of quality. The best was *cūā khār*, which Mian Allah Baksh said was colored red, sometimes whitish or green tinged, and was porous or coarsely sponge-like, with a nonlustrous, earthy appearance. The very best quality was indicated by the *khār* having the greatest porosity. The second grade material (*roṭā*) was usually whitish in color. The third grade, called simply *khār*, had a dark green color, was dense and nonporous, and had the appearance of charcoal (lustrous). Often the third grade product contained many visible pieces of charcoal incorporated in the dark green groundmass.

This grading process has been referred to by Abū'l-Qāsim (quotation on p. 181), who stated that the best quality material had a "red-coloured centre when broken, with a strong smell." The description of red color agrees with the preceding outlines. Samples of the Cholistan material (listed in Appendix 1) all gave a strong smell of sulphur when broken, so it is likely that the smell referred to by Abū'l-Qāsim was also that of sulphur. Photographs of the *khār* bush and the ash products are reproduced in Plate 74.

Remnants of the burning pits can be seen in some areas of the Cholistan Desert. They appear as lenticular depressions, usually some 2 to 3 m in diameter and 0.5m deep. The original pits fill with wind-blown sand in about 12 months to this extent. New pits are dug for each production season.

The process of *khār* production outlined above may be compared with the descriptions given by other writers. It differs slightly from one process described by Wulff (1966:161) from Qom, Iran, where the burning of various plants produced a "soft" ash, which was afterwards calcined in special muffle furnaces. Elsewhere, Wulff, Wulff, and Koch

(1968:100) described the Qom process differently, stating that the burning ashes "sinter into hard blocks." The latter description appears closer to that of the Cholistan process.

In the past, *khār* was also prepared at Multan, although the writer found no evidence to suggest that it still was in 1971. The process was slightly different to that described above from the Cholistan. In a quotation from the *Multan Gazeteer* (Maclaglan, 1902:229), Parker (1918:418–419) outlined the process. The pit was much smaller, about 1 m in diameter and 0.3 m deep. The bush was "piled to a considerable height" above the pit, and burned "so that the plant-juice ran into the pit." Then "when the hole is full the juice is stirred for a couple of hours with a stick after which a little earth is sprinkled on the top and it is allowed to cool when it solidifies into a hard mass."

Unfortunately, no comment can be made about this description because the writer has not personally witnessed the process. Comparing the description with that given by Mian Allah Baksh there is an overall similarity, except that the stirring and sprinkling of earth over the top mentioned in the Multan description would almost certainly incorporate various minerals in the *khār*.

According to Parker (1918:418–419), *Haloxylon recurvum* was the bush burned in the Multan process, a hint that this bush may have been used widely in that country. As mentioned above, *khār* preparation seems to have now ceased at Multan. Both potters and *khār*-sellers in Multan bazaars indicated in 1971 that their source of supply was the Cholistan production. It is probable that when *khār* was being produced in Multan the potters used the local material for glaze making, and that sometime between about 1920 and the present they changed to using the "imported" material. Examination of the general quality of glazed vessels from Multan made between 1900 and the present time provides no evidence of a dramatic change in quality or appearance of Multan glazes, suggesting that the *khār* produced in Multan was not significantly different from that now produced in the Cholistan Desert, some 100 to 130 km southeast of Multan.

The *khār* produced in Bahawalpur/Cholistan was said to be used for a soap substitute (the worst grade material), or in the production of soaps. Better grades were used in the production of medicines, in the manufacture of explosives, in leather dyeing and tanning, and as a substitute for caustic soda in various applications.

Fusion of *Khār* Samples

Samples of *khār* were collected from Mian Allah Baksh, in Bahawalpur, and from various other localities in Pakistan. These samples, all deposited in the Department of Anthropology, Ethnology collection, Smithsonian Institution, are listed in the catalog in Appendix 1.

Analyses of the samples were not available at the time of writing. A brief study of fusion behavior of the plant ash has been made as a preliminary investigation of the differences between various samples. Four samples are included in the following report: USNM 417,176; 417,177; 417,178 from the Cholistan, respectively described as "first," "second," and "third" grade by Mian Allah Baksh; and USNM 417,590, a sample provided by a Multan potter as being representative of the *khār* used in Multan glazes.

All four samples were in the form of rock-like blocks (Plate 74). For these preliminary observations small pieces were broken from the blocks (each piece about 5 g). The small pieces were heated in an electric kiln to temperatures between 600° and 1000°C.

The Multan sample was the least fusible of the four. Fusion had commenced by 900°C; after heating to 1000°C a sample piece had fused and flowed, and had a frothed appearance.

The fusibility of the three Cholistan Desert/Bahawalpur samples varied with the grading made by the local producer. The first grade was most fusible and the third grade least fusible. The results are summarized below, with the behavior of the Multan sample included for comparison.

Sample	*USNM*	*Fusion begins* (°C)	*Extensive flow* (°C)
First	417,176	ca. 600	700–750
Second	417,177	600–730	800–900
Third	417,178	700–750	900–1000
Multan	417,590	800–900	900–1000

As analyses of the samples were not available at the time of writing the differential behavior of the samples cannot be explained on a compositional basis. It is surprising that the Multan potter's *khār* sample was one of the least fusible and comparable with the third grade material from Cholistan. Inhomogeneity of the original samples was not noted when these sample tests were repeated over a number of trials; the fusion behavior was similar each time.

It is interesting again to relate these results to the writings of Abū'l-Qāsim. His reference to the "best" plant ash, quoted above, can now be interpreted as the most fusible or that which fuses at the

lowest temperature, on the basis of the similarity of description of the best grade Cholistan plant ash and Abū'l-Qāsim's "best" plant ash.

Many questions are unanswered at this point. Why do the Multan potters use the least fusible grade of *khār?* What compositional variations are there between different grades of plant ash? How does the composition of plant ash for use in glazes differ from those used for other purpose? Where else in Pakistan is plant ash produced: what plants are used; what is the ash used for? Further studies will provide answers to questions such as these.

Appendix 4

ELECTRON MICROPROBE ANALYSES OF FIRED GLAZES

J. Nelen and Owen S. Rye

Introduction

Studies of materials used by, and collected from, present day potters in Pakistan are reported herein. In the study of glazing materials it was necessary to obtain data on the composition of fired glazes, for two main reasons. The first was that such data could provide a check on information supplied by potters regarding their techniques of glaze making, this being particularly desirable where field studies did not allow complete observation of processes and only verbal descriptions of techniques could be obtained from the potters.

Secondly, it is obvious that the study of present day potters working by traditional methods may in some way give insight into the techniques of potters in the past; particularly where there is evidence of continuity of tradition. In many cases, however, all that remains from the past is the fired vessel, perhaps with data relating to provenience, but with only vague evidence of its technological origins.

It is desirable, then, to develop methods of study of vessels, which may alike be applied to both new and old vessels, and which may provide reliable compositional data enabling interpretation of the technological origins of the older vessels.

Part of the aim of the present study is to evaluate the application of the electron microprobe to the study of glaze samples removed from vessels for which the technological history was known, both in order to learn more about these vessels and to determine whether the technique could provide useful comparative data in the study of older vessels. This instrument offers several advantages over alternative methods of determining the composition of glazes. It provides quantitative data, in contrast with traditional optical spectroscopic analysis, which at best is semiquantitative. X-ray fluorescence requires samples of such size that it may be considered a destructive technique where rare or irreplaceable vessels are to provide analytical samples. Classical silicate analysis by wet methods gives very precise quantitative data but is both expensive and time-consuming, and in many cases again requires samples of a size which could be considered destructive of the artifact.

The microprobe, by contrast, requires only very small samples (chips of glaze as small as 1 mm may be mounted and analyzed), so with careful sample-removal techniques it may be considered nondestructive. Another advantage is that specific small grains or crystals embedded in the glaze sample can be analyzed. It gives quantitative data of high precision, although the precision limits are broader than for classical silicate analysis. Once the samples have been mounted analytical determination can be made very quickly, the time of course varying with the number of elements to be determined for a particular sample. For example, a nine-element determination by a skilled analyst of up to 40 separate samples in one day is possible. The data can then be processed quickly with appropriate computer programs.

Unfortunately, there are some deficiencies inherent in this analytical technique. The microprobe is not the most suitable instrument for quantitative determination of the first eight or nine elements in the periodic table. Thus boron, one of the elements present in many glazes, presents a problem. Although boron x-rays are detectable with a special crystal and detector, the boron content of glazes can best be determined by other methods. Also, glazes with high-lead content present problems because of matrix-correction difficulties with this element. Finally, because of the very small area covered by the electron beam (in the approximate range 1–50 μ) sample inhomogeneity can be a major problem.

Sampling

With recent vessels, having little value as exhibition pieces and easily replaceable because of their continuing manufacture, sampling did not present such a problem as it might with rare or valuable pieces. For the present study, the sampling technique was to some extent destructive, but experimentation showed that the sampling technique could be refined so that only very small samples (still suitable for analysis) of glaze could be removed from an inconspicuous part of a vessel without any effect on its exhibition value.

Small areas of glaze were removed from vessels with the aid of Vibro-tool with a tungsten point. It was found that a small circular (about 0.2–0.5 cm diameter) piece of surface material with glaze, slip if present, and body could be detached by first scribing a circle on the surface of the vessel, then continuously moving to tool around this circle to deepen the groove, with the point of the tool perpendicular to the vessel surface throughout these operations. The tool was then held at an angle such that the sample area was undercut; the sample piece then could be detached easily. An adjustment on the Vibro-tool allowed variation of the vibration frequency. Slower speeds were found suitable for sampling alkaline glazes; the harder lead glazes required a high-frequency vibration.

The samples obtained by this method enabled a complete examination of the cross-section through body, slip, and glaze when mounted. If nondestructive sampling was a major criteria, however, chips of glaze alone would be removed. Some experimentation with the sampling technique showed that it was completely applicable to that case, leaving only a small scar in the glaze, which could be restored easily to its former appearance.

Sample Mounting

The samples were mounted as thin sections on glass slides, bonded to the glass with epoxy resin, and polished to a thickness of 30 μ to enable the application of petrographic thin-section study techniques in addition to the microprobe analyses. It was found that up to 12 sample pieces could be mounted on one 2.5 cm (1 in) diameter glass slide. A total of seven such multisample slides, in addition to a standard slide, could be placed in the instrument at one time.

After thin-section study and the preparation of photomicrographs of each slide, the slides were carbon-coated by standard methods and subsequently analyzed.

Analytical Methods

The analyses were performed using an ARL EMX microprobe with three scanning spectrometers and 52.5° take off angle. The crystals available were LiF, ADP, and RAP.

The glaze sections were first analyzed for nine major elements (Na, Mg, Al, Si, P, K, Ca, Ti, and Fe). Care was taken to select areas for analysis that appeared to consist of uniform, homogenous glass. Counts were checked continuously in order to detect wide variations which would indicate inhomogeneity. Crystalline inclusions were checked for composition, but were otherwise avoided in the analysis. A beam size of 25 microns was used. The initial nine-element analyses were corrected by Bence-Albee techniques (Bench and Albee, 1968; Albee and Ray, 1970).

The elemental analyses were converted to oxide equivalents. Summation of analyses for each sample showed that while some totals were close to 100 percent, others gave low summations, indicating the presence of elements other than those sought in the intial nine-element analysis.

Subsequent scans of selected samples showed the presence of other elements, notably Pb, Cu, and Sn, but including colorants (for example Cr, Mn, and Co), which in combination with others were responsible for the characteristic colors of some of the glazes. Chlorine was present in traces in some glazes; sulfur was not detected in any sample. No other elements were detected in significant quantity.

A further analysis of all the samples was then carried out, in which these six elements (Pb, Cu, Sn, Cr, Mn, and Co) were sought. The data was again corrected by Bence-Albee techniques, this time on the basis of the complete fifteen elements. The corrected values are given in Table 12. For Pb, the M alpha line was used; for Sn, the L alpha line; and for all other elements, the K alpha lines.

Although the summations for the glazes containing lead were slightly high in the final data, they were considered acceptable for the purpose of this investigation. In some other analyses low summations were thought due to the presence of boron, an element that could not be checked with our facilities.

Precision of Analytic Data

Precision levels for use with the data given in Table 12 are reported below. These were estimated on the basis of data obtained from a number of previously analyzed glass standards (synthetic Corning Glasses, etc.), which were employed as controls and

analyzed at the same time as the experimental samples. Because the composition of these controls was accurately known, it was possible to calculate the precision of our glaze analyses.

For glazes with PbO content below 5 percent the accuracy is: reported value above 5 percent, ±3 percent relative from true value; reported value 1 to 5 percent, ±5 percent relative from true value; reported value 1 percent or less, ±0.1 percent absolute from true value.

For glazes with PbO content greater than 5 percent the accuracy is: reported value above 5 percent, ±5 percent relative from true value; reported value 1 to 5 percent; ±10 percent relative from true value; reported value 1 percent or less, ±0.2 percent absolute from the true value.

Twenty-nine analyses are given in Table 12, and are discussed in detail on pages 147–160. Analyses in Table 12 have been reported with the analytic totals, not recalculated to 100 percent totals. The analytical data has been recalculated also to express the glaze compositions as molecular equivalents of oxides, which allows comparisons of glazes because the molecular equivalent calculation is dependent only on the *proportions* of oxides present; the ratios would still be the same had the original analyses been recalculated to a total of 100 percent. Molecular ratios are given in Table 13.

Appendix 5

KULĀL-NĀMA: THE POTTER'S BOOK

Owen S. Rye

Introduction

This appendix is a distinct departure from the technological emphasis of other parts of this work. It is partly the account of the dedication of a potter to his religion, and it includes a translation of a book, the *kulāl-nāma*, or potter's book, which for him expressed the origins and sanctity of his craft.

The potter was Khan Zada of Dir, in the North-west Frontier Province, north of Peshawar. His work has been discussed (p. 16). In 1971, during the course of field work in Pakistan, we spent some ten days around Dir; I was at Khan Zada's workshop for much of this time. The following notes serve to place the potter's book in context. They are expanded from my field notes with some minor changes to provide continuity in the text. The notes begin on a day when the potter was setting and firing his kiln.

Extract from Rye's Field Notes, April 1971

11 April: Khan Zada has finished setting the kiln; the firing about to begin. A woman from the potter's family has collected some small pieces of kindling from the stockpile of wood normally used for cooking and heating in the home. She places them in an opening in the front wall of the kiln and lights them with a match. While she does this the potter is squatting on top of the front wall of the kiln [Plate 17g]: he had just gone away somewhere and returned with a small bowl of white sand (micaceous—from the river?). He holds the bowl in his lap and starts to say something in a very soft voice: most of the spectators—30 or so—keep silent while he is talking. Khalil says that he is saying some special prayers for the safety of the pots in the kiln. Khalil (the interpreter) says he is reciting verses from the Qur'an. I asked where he had learned the prayers: Khan Zada says that they had been recommended to him by a *mullā* [1] in Dir when he had started working as a potter.

When he finishes he holds the bowl of sand in one hand and sprinkles the sand over the top of the setting with the other, with a few nice sweeping movements. Then he moves away from the kiln and tells Khalil that the firing has begun. Khan Zada wants to explain why the firing was started by women rather than by himself. He said that it was not because he would burn himself, because he could still light fires safely, but because it was difficult for him to go down the stairs to the front of the kiln. He is almost blind and the women help him with many jobs, and I asked him to tell which jobs he had done himself when he could see properly, and which had always been the responsibility of women.

Then I asked him about the prayers. Were there prayers for other parts of the pottery-making process or only for firing? He said there are also prayers for use when collecting clay, and that some potters memorize them and others read them from the Qur'an. I could not imagine a potter digging clay and reading from the Qur'an at the same time, but leave it at that. He said that because he was not literate he had had to learn the verses from the *mullā*. He said that there are prayers for four occasions: leaving the house to go out and dig clay; while digging the clay; while the fire is being started in the kiln; and while the pots are being removed from the kiln. Khan Zada cannot see well enough to go out and dig clay for himself, and told me that his daughters dug the clay for him. I asked him if he had taught them the prayers, but he said "no," that it is the potter's duty to say the prayers, so he says them when his daughters go out for clay. He said that potters who read or recite the prayers are considered to be a better class of potters, and I asked him what he meant by "better." He said they are *halāl* (Khalil explained that that means "spiritually better" or pious). Khan Zada said that any potter who does not say the prayers is *hārām* (Khalil said that the potter means this as "earning a living by dishonest means," which seems like one of Khalil's legalized definitions—he has studied law—so I make a note to check the word somewhere else).

I asked about the bowl of sand and the sprinkling of sand over the setting. Khan Zada said that he only uses the best type of white sand from the river, or else sometimes he uses salt if he has no sand. He said that when he repeats the prayers then the salt or sand takes in, absorbs, the spiritual power of the verses, and when he spreads the sand this is transmitted to the pots.

I asked him if he knows of any other prayers for potters. He said that prayers exist for all pottery processes, but that he has only learned four of them. He said that they are all written down in a book called "*kulāl-nāma*." ("the potter's book"). Does he know what is in the book? He said that it contains the history of various prophets, and that there are verses at the end of each history. He said that there are special prophets for potters. He explains that there are a total of 1313 prophets, but that he is not clear whether or not all of these are spe-

cifically prophets for potters, but he does not think so. (Khalil began to explain about the prophets but I told him to wait until later, I wanted to hear the potter's version.) Khan Zada says that pottery first started at the time of Adam, and that the verses and histories have been written down from that time onwards.

At that point we had to leave for the day, so I asked him if he could tell me more about it and he said he would the next day.

12 April: When I arrived he came out and greeted us. Then we went to see him take the fired pots from the kiln. We did not talk about the prayers that morning. After lunch, when we returned, he went into the house and came back out with a book that looked at least millennia old. Yellowed and generally chewed about, with a board cover at the back but no front cover, he said that this is the book of the history of potters and their prophets and contains the verses of prayers for potters. He said that he bought this book 30 years ago from the *kitāb firosh*, who were people who traveled around selling books. They also bought leather sieves [Plate 12] made by the hill people in Kohistan and sold them to villagers along the river; the villagers used them for sieving grain.

Khan Zada said that his copy of the book is not complete, that the part which refers to potters has been eaten by mice in the house, and it is missing. After some discussion the real problem emerged. Khan Zada considers this to be a holy book; it is the only book he has ever had; the *mullā* told him that he must always keep the book in his house, and he is very reluctant to move it from the place where he has kept it for so long. It became clear that he had completely and literally accepted what the *mullā* had told him. Because of this he viewed his work as a spiritual, as well as a practical, activity. He explained that the book which he has is only for potters, but that there are also books for other craftsmen—he knew of one for blacksmiths. (Khalil translated some of the book generally so we have some idea of the contents; he said it is a type of Pashto poetry.)

Later Khalil said that Khan Zada offered to lend us the book for one night only so that we can make a complete translation of the eight pages. Afzal Sarwar, circuit judge from Nowshera, who was staying at the Dir rest house, offered to do the translation, and we sat up most of the night to do so. Sarwar said that translation was difficult, because of the problems of selecting English synonyms that can represent the intent of the original. Sarwar could not read the Arabic (Qur'anic verses), but for some obscure reason the rest-house cook knew a little Arabic so he translated them.

13 April: When we returned the book early in the morning, Khan Zada told Khalil that he had not slept all night because he had been told by the *mullā* to always keep the book in the house, and this was the first night that it had not been in the house for 30 years.

Comments

While the book was in Rye's possession, we photographed each page, but later, after making many inquiries in Peshawar, Khalil located a copy in a bookshop in the *Qissakhwānī Bāzār*. This copy was printed on newsprint-quality paper; I had forgotten to note what type of paper was used in Khan Zada's copy, but remembered it as a better quality paper, which had been badly yellowed by exposure to woodsmoke inside the house. The copy purchased in Peshawar, now in my possession, also contains the sections intended for other artisans than potters. The first eight pages were identical to those in Khan Zada's copy; the complete book had 24 pages, the last 16 referring to other trades or crafts. The translation given below is of the first eight pages only, the *kulāl-nāma*, the potter's section.

Qur'anic quotations in the translation were taken directly or with slight amendments, from the translation of Arberry (1955), except for the reference to Surah 2, 132, where the translation made by Dawood (1968) is more appropriate. Two of the Qur'anic quotations (Surah 61, 13, and Surah 34, 12) have direct relationship between the part of *The Potter's Book*, that is the specific pottery process being discussed, and the context of the Qur'anic quotation. For example Surah 34, 12, is found in a section of the Qur'an that refers to Allah's provision of materials for artisans, or more generally "Allah provides in bounty."

Other than these two references, the verses from the Qur'an quoted in *The Potter's Book* do not have any direct reference to craftsmen; they provide guidance for the followers of Mohammed in a more general sense.

It is slightly surprising that some of the potential symbolic relationships between the pottery craft and the Qur'an have not been utilized. An example of this would be the symbolism of the vessel being created from earth, being submitted to the fires and being "reborn." *The Potter's Book* as a whole, as MacKenzie (pers. comm.) has suggested, does not give the impression of a work of scholarship or poetic insight; rather it has the character of a work intended for village craftsmen.

The numerous references to Ṣūfi saints suggest that *The Potter's Book* was intended for craftsmen who followed one of the Ṣūfi orders. Several references are made to saints of the Nakshbandī order who lived and died near Bukhārā. Considering that the author mentions at one point that *The Potter's Book* was based on Persian originals, it is possible that such original works could be located, and that similar works are used by potters in other Islamic countries neighboring Pakistan. Definite evidence of this has been provided by Professor Matson (pers. comm.), who photographed a copy of *The Potter's Book* in the possession of a potter in Charekar, Afghanistan. Matson's copy is identical to that in Khan Zada's possession, both being identical to the copy in my possession, which was purchased in Peshawar. This suggests that the book may be circulated in areas

where Pashto is spoken and that further copies may be located in these areas, or further that the book may have wider significance than has been indicated in this appendix. It was Matson's suggestion that *The Potter's Book* could be related to the Nakshbandī line of succession of saints.

In summary, *The Potter's Book,* translated and discussed in this appendix, relates the daily life of the potter to the practice of Islam, and suggests that he works in a tradition established by Islamic saints, primarily those of the Nakshbandī line of succession of Sūfis. Further research may clarify the origins of the book, which, it is suggested, will be in Persian literary sources.

Translation

The craft is beloved of Allah.

PROFESSIONAL BOOK OF POTTERS, CARPENTERS, AND BLACKSMITHS, WASHERMEN AND BARBERS.[2]

COLLECTION OF PROFESSIONAL BOOKS

Hāji Fazl Ahad and Hāji Abdur Rahīm and Sons, Book Sellers
Qissakhwānī Bāzār, Peshawar

Description of the Potters' Profession

I always and every time recite prayers of Allah
Who is kind and merciful and understands every work.
He is immortal and will remain forever; everybody except him will die.
He wants for no advice, and conducts his kingdom without assistants.
Even kings with crowns are dependent on him.
Mohammed is his prophet, and he is accepted in His court.
On the day of resurrection he [Mohammed] will ask forgiveness for his followers.
O believer, have a firm faith in the religion of Mohammed.

Principles of Pottery

O potter, it is necessary for you to know these facts.
From this craft you can earn your livelihood.
O young man, learn the book of your craft quickly.
If you have not the ability to remember or learn, or have not the opportunity to learn, O my dear friend, keep this book in your house.
Look through this book every morning.
O potter, I am telling you that your livelihood will be an honorable one.
If you do not act according to these instructions, then your whole work will be spiritually bad.
Your livelihood will be dishonest. I am telling you these facts.

Question: If somebody asks you the question: From where does the art of pottery come? Then answer him so:

Answer: It has come from Salh Abū'l-Hasan,[3] who was the son of Mir Umar,[4] who was a man of fortune in the world. This has been said by Ja'far,[5] who recounts that the experts and teachers in this profession were three hundred and thirteen in number. It has been said in the books that all of them were prophets. After them were seven hundred good-willed teacher-artisans. They were all saints and had adopted this profession.

Question: O potter, if someone asks you the question: who originally laid the foundations of the profession?

Answer: Tell him immediately that in the time of Adam the angel Gabriel brought all the tools, by the order of Allah, to Adam.

Question: If someone asks you this question, and wants the answer without hesitation: Who continued the work after Adam?

Answer: Tell him at once that Noah did this work successfully. After him Abraham did this work intelligently. After him Isaac did this work with great fondness. Then by the order of Allah, this work was done by Moses, the man who talked with Allah. After that this work came to the prophet Muhammad. After him Ali,[6] the saint of Allah, did this work as a pasttime. After him Abū'l-Hasan [7] learnt this art and disclosed it to the world. Then this art became well known to all the people in the world.

Question: If someone asks you a question in such a manner: Who was the spiritual leader [of the pottery profession] and who did the research on it?

Answer: Tell him that the first perfect spiritual leader was the angel Gabriel and that the last perfect man in the art was Mir Kulāl,[8] the leader of potters.

Question: If someone asks you how many spiritual leaders and teachers there have been in this profession, then answer like this at once:

Answer: In the answer you should tell them at once, O my wise friend, that the leader of this profession was Abū'l-Hasan,[9] a man of courage who was kind to the poor and generous with his learning.

Question: If someone asks you of this profession, who had the first workshop [10];

Answer: Tell him this fact and make his heart happy. From heaven Adam had brought it first; the stone [11] was brought by him from heaven.

Digging the Clay

When, O potter, you start digging the clay, I tell you O my friend, then you should recite the following verses: "In the name of Allah, the merciful and kind: 'Help from Allah and victory nigh'." [12]

Beating Clay in the House [13]

If you make a heap of clay and prepare it for kneading, then recite aloud the following verse, O my beloved brother: "In the name of Allah who is kind and merciful: 'Labor, O House of David, in thankfulness; for few indeed are those that are thankful among my servants'." [14]

Kneading of Clay

O young man, when you prepare the clay, whether it is sandy or fine, then you should repeat the following verse and your work will benefit: "Blessed is he who has sent down the Salvation [15] upon his servant." [16]

Sitting at the Wheel [17]

When you sit at the wheel then sweep the place with your own hand. Say these words O my good friend: "This is a clay which has been prepared by the leave of Allah."

Placing Your Foot on the Wheel

When you place your foot on the potter's wheel, then you should recite the following verse and you will never get tired; the verse is as follows: "Take counsel with them in the affair; and when thou art resolved put thy trust in Allah." [18]

Placing Clay on the Wheel

When you place the wheelhead on the wheel and place clay in the mold and want to make a pot from it, then recite this verse loudly: "Surely Allah loves those who put trust [in Him]." [19]

Making a Ewer (*Kūzā*)

Listen, O potter friend, so I may let you know the facts. When you want to make a ewer, then you should recite the following words: "There is no strength but in Allah." [20]

Making a Water Storage Jar

When you prefer to make a water storage jar, and place the clay on the wheel, you should recite this verse with love, and your sorrow will disappear: "Truly, Allah is powerful over everything." [21]

Making a Lid

When you want to make a lid from above and below,[22] you should quickly repeat the following verse: "Truly, it is from Solomon; in the name of Allah who is merciful and kind."

Painting the Pottery

O dear potter, when you make the pots ready, and you want to paint them, then you should recite this verse: "We take our color from Allah. Who has a better color than Allah's?" [23]

Smoothing of Pottery with a Stone

When you take a stone in your hand intending to smooth the pottery then ask for help from Allah and recite this verse: "Allah prevails in his purpose but most men know not." [24]

Setting Pots in the Kiln

When you put them in the kiln and heap the fuel on them you should recite these prayers and leave the rest to Allah: "O Allah save them from all calamities and damage and from the rain." [25]

Opening of the Kiln

O potter, before opening the kiln you should perform ablutions, O good mannered one, and after that recite this verse, and the kiln will be blessed: "Come, sweet patience. Allah's succor is there in your misfortune." [26]

Listen, O dedicated ones, it is necessary for potters that each must abide by these conditions. When the kiln has been fired and is ready, you should hear these words; give alms in the name of your spiritual guides. All the former master potters are your guides. Mir Sayyid [27] is their leader, and Mir Ḥusaynī was his son. His second son was Mirzā Shāh, who was beyond value in mystic power. All these three persons were saints and were masters of this profession. Listen to these instructions: When potters give alms, they should name all three in a loud voice. Then the potter who gives these offerings will never be poor and his work will thrive. He will be respected by the people and will be an influence to them. He who does not so practice will be Allah's thief. You should raise your hands and pray for Ni'matullāh.[28]

NOTES

[1] In Pakistan and Afghanistan the *mullā* is the villager's religious teacher, guide, and advisor in the Islamic faith.

[2] *The Potter's Book* is a title adopted here for convenience, to distinguish the translated section of the book from the complete work. The pottery section is written in the form of Pashto poetry, in Pashto script; verses from or references to the Qur'an are written in Arabic script.

[3] Probably intended to refer to "Hasan of Basra," a prominent figure in the first century of the Hidjra. Al-Ḥasan al-Baṣri (A.D. 642–728; 21–110 AH). He exercised a lasting influence on the development of Ṣūfism by his ascetic piety, and numerous pious sayings are ascribed to him.

[4] Second of the caliphs (khalīfas) after Muhammad.

[5] Ja'far Sādiq, saint in the Nakshbandī succession, the seventh Shi'a Imām.

[6] Khalīfa after the Prophet Muhammad, regarded widely in Sufism as primary heir to Muhammad.

[7] See note 3.

[8] Saint in the Nakshbandī succession. According to Subhan (1960: 190) he died in 1371. Full title *Khwāja Amir Sayyid Kulāl Sokhari*. Sokhar, near Bukhārā was the place where he was born and buried. He worked as a potter and was for a time the teacher of Muhammad Bahā'al al-Bukhārī, known as Muhammad Nakshband, to whom the origin of the Ṣūfi order, Nakshbandi, is attributed.

[9] Cf. note 3.

[10] The word "*dukān*" from the Persian means "place of work" and is used to refer to the potter's workshop in general, but it is used also to refer to the potter's wheel. See note 11.

[11] The "stone" referred to is either part or whole of the potter's wheel; cf. note 10.

[12] Qur'an, Surah 61, 13.

[13] In Pakistan clay is brought in from the deposit, dried, and then broken into small lumps by beating the pile with a stick. This method is also used in other parts of the eastern Islamic countries.

[14] Qur'an, Surah 34, 12.

[15] "The Salvation" is the Qur'an.

[16] Qur'an, Surah 25, 1.

[17] Literally "workshop" (*dukān*). See Plate 14.

[18] Qur'an, Surah 3, 153.

[19] Translated as Qur'an, Surah 153, 3.

[20] Not from Qur'an.

[21] Occurs frequently in Qur'an, as Surah 2, 19.

[22] Apt description; see page 22.

[23] Qur'an, Surah 2, 132. Arberry (1955, I:45) translates as: "the baptism of God: and who is there that baptises fairer than God."

[24] Qur'an, Surah 12, 21.

[25] Not from Qur'an.

[26] Based on Qur'an, Surah 12, 18.

[27] Sayyid Muhammad Gesū Darāz, saint of the Niẕāmī section of the Chishtī order of Sufis; his full name, with all titles, translates as "Muhammed Husaiynī of long tresses and kind to his servants." Born in Delhi, later lived in the Deccan. His two sons were Sayyid Husaynī, known as Sayyid Muhammad Akbar Husaynī, and Sayyid Yūsuf, known as Sayyid Muhammad Asg͟har.

[28] Dr. D. N. MacKenzie (pres. comm.) has suggested that the author was Mullā Niʿmatullāh, of Nowshera, a popular poet of the 1880s period, who versified many romances based on Persian originals.

Appendix 6

A GUJRATI POTTER'S LEGEND

Owen S. Rye

The work of potters in Gujrat has been discussed in the main body of this monograph, and reference has been made to the legend of Sohni and Mahinwal (page 57 and Plate 37*d*). Very thin-walled bowls of unglazed red earthenware are made by some Gujrati potters and are sold mainly in the pottery bazaars of Gujrat. Ahmed Din, master potter of Gujrat, recounted the following legend to Rye, and said that it was a traditional story known to most of the potters of Gujrat. The story was repeated in general outline by two other Gujrati potters, but is given here as told by Ahmed Din. The only written account of this legend that I could find was in Abbas (1957:87–96). In all but minor details, the two accounts are similar.

The potters of Gujrat make a fine *piālā,* drinking bowl, in the same style as has been made for many hundreds of years. It is known as "Sohni's bowl," after Sohni of the old legend of Sohni and Mahinwal. Sohni was thin and fragile, like the bowl, and beautiful. Her father was a potter, and he was the first man to make bowls like this. He must have been a very good potter because today only the very best potters can make these bowls.

Mirza Izad Beg was a prince, who was related to the royal Mughal family of Delhi. Like the other Mughals, he used to holiday in Kashmir in summer because the hills of Kashmir were cooler than the plains of Delhi. From Kashmir one summer he decided to return to Delhi by way of Lahore. On the way to Lahore he stopped at Gujrat, where he heard of the very fine bowls made by one of the Gujrati potters. He decided to buy some of these bowls to take with him.

When he went to the potter's shop to buy the bowls he saw Sohni, who used to sit in the potter's shop. He was so awed by her that he wanted to see her again, so he bought some bowls and went away to plan how he could speak to her. No one knew his true identity, so his plan was simple. The next day he went back to the potter's shop, and said that he was so impressed by the fine bowls that he wanted to learn how to make them and to become an apprentice to the potter. The potter had no idea that his visitor was a prince. The previous day his clothes had been dusty from travel, and this day he wore peasant's clothing. So the potter listened sympathetically; but he was jealous of his skills and would not teach them to anyone. Instead, he offered the visitor a job as a cowboy, tending the potter's buffalos. The prince accepted, but before he left the shop he made it clear to Sohni that she, and not the work, was the reason for his visit.

The prince became a tender of buffalo, a *māhinwal.* His plan had worked, because Sohni had been sufficiently intrigued that she wanted to meet the stranger. This seemed impossible because the buffalo were kept on the other side of the Chenab River, which flowed much closer to Gujrat than it does now. She devised a plan of her own. One night she waited until after dark and took a large pot out of the shop. She carried it down to the river and, by turning it upside down, she was able to use it as a float and cross the river. This way she had her first meeting with Mahinwal, and in the same way they met many more times.

Inevitably, the potter found that they had been meeting, and forbade Mahinwal to see her again, and told him that his job was finished. But as the potter had not discovered how or where they met, Sohni was occasionally able to cross the river in secrecy. Eventually the potter heard that they were still meeting and was furious; even more so when he learned that Sohni had not only been meeting Mahinwal but had been taking food from the potter's own house to keep Mahinwal alive. The potter went out and arranged a marriage for Sohni, and very soon she was married to another man.

This was not enough to stop her meeting with Mahinwal. She still went out at night, when she

could, and crossed the river using the pot which she had hidden behind a bush near the river.

Finally the family of Sohni's husband became suspicious at her behavior and decided to watch her at all times. One night the husband's sister saw Sohni leaving the house, followed her to the river, and learned the secret of the river crossing. The sister determined to revenge her brother for Sohni's behavior. When Sohni was busy at work the sister went to the potter's shop and took an unfired water pot from a pile that had been left out to dry. She took it to the river, to where the other pot was hidden, and exchanged them.

That night Sohni again left the house and went to the river in the darkness. Because of her haste and the darkness she did not realize that the pot had been changed. She waded into the Chenab, turned the pot upside down, and began to float and swim across. As the pot became soaked with water the unfired clay disintegrated in her hands. Because she could not swim without the pot she screamed; and because she could not swim without the pot she drowned.

Mahinwal, waiting on the other side of the river, heard her scream. Heedless of the fact that he could not swim himself he dived into the river to save her; and so it was that both lovers drowned in the waters of the Chenab. Thus, in Gujrat today, the best potters make the fine bowls in memory of the beautiful Sohni and her Mughal prince.

Glossary

ANNA. The obsolete Indian term of currency often still used in Pakistan; 16 annas equal 1 rupee.

ANVIL. Flat or slightly round-faced tool used to support interior walls of a leather-hard vessel being formed by a paddle.

BATT. Essentially a flat slab of any material. The term can be used to refer to a kiln shelf, or to a wooden slab used as a shelf, working surface, or for other purposes. Also for tiles temporarily used by potters as a flat working surface.

BEATER. Synonymous with PADDLE.

BISCUIT. Ceramic ware that has undergone the first firing before glazing; unglazed ware that has been fired once.

BODY. Blend of clay and temper used to form ceramic shapes; a piece of ceramic ware distinct from its glaze.

BONE DRY. Stage of drying of a clay vessel when no further water is lost to the atmosphere under natural drying conditions.

BUNG. Fired piece of clay used as a stopper to seal the spyhole of the kiln to keep drafts of cold air from entering. Removed while observing the interior of kiln; replaced at other times.

BURNISHING. Smoothing the surface of a leather-hard vessel with a smooth, hard object to give a lustrous finish. See POLISHING.

CALCINING. Heating a rock, mineral, etc., in a furnace or kiln to a temperature below its fusion or sintering point. Decomposition may result, as is the case with limestone, or stresses may develop due to mineral expansions and contractions. In the latter case, for example with flint, the materials become easier to crush.

CENTERING. Applying pressure to a lump of clay on the potter's wheelhead to position it correctly in order to give it even rotation.

CHAMBER. Enclosed section of a kiln where pottery vessels are set for firing.

CHIMNEYING IN AN UPDRAFT KILN. Process by which flame establishes a preferential path through the setting, thus locally increasing the heat and hence the draft, which together increase the effect further.

chiṭānk. Unit of weight referring to $1/16$ of a seer, which is a Pakistani unit of weight approximately equivalent to 1 kilogram.

CHUCK. A device made from fired or unfired clay for attaching a leather-hard or dry vessel to the potter's wheel, so its form may be further modified by an operation such as turning.

cilam. Either the base, or lower vessel, of the tobacco smoking-pipe device or the entire device, consisting of the bowl for the tobacco, called "*topī*," the base vessel and the connecting pieces and tubes. The word "*hookah*" refers only to the complete device with all its parts and is synonymous with *cilam* when used in that sense.

CLAY. A naturally occurring material composed primarily of clay minerals.

CLAY MINERALS. Hydrated aluminosilicate minerals with sheet or layer crystalline structure, such as kaolinite, montmorillionite. The essential mineral constituent of clays.

CLEAR GLAZE. A glaze that has a very low colorant content, and is also transparent, thus readily showing the colors of body, slips or pigments over which it is applied. Not necessarily synonymous with TRANSPARENT GLAZE.

COLORANT. Oxides or other compounds of metals, such as Fe, Cu, Mn, Co, which are mixed with a glaze batch to give the fired glaze characteristic colors.

CORBELLING. Term used in brick working to refer to the stepping outward of brickwork by successively extending bricks out over those in the course below.

COURSE. A continuous level range of bricks throughout a brickwork structure.

CROSS-DRAFT KILN. Kiln in which flame travels horizontally from firebox, through the chamber and through flues to chimney.

CROWN. Dome, arch, or other structure covering the chamber of a kiln.

CULLET. Broken or refuse glass that is added to a batch of new material to facilitate melting in manufacturing of glass or glaze.

CUTTING OFF. Cutting underneath a newly formed clay vessel on a wheelhead so it may be removed.

DIPPING. Applying a glaze, slip, etc., to a vessel by partly or wholly submerging the vessel in a liquid, usually water, suspension of the glaze or slip.

DOME. Continuous circular vaulted structure in brickwork or masonry.

DOWN-DRAFT KILN. Kiln in which flame travels from the firebox over a wall before passing down through the chamber to flues and chimney.

DRAWING. Removing fired pottery from a kiln after firing.

DUNTING. Cracking of fired vessels due to too-rapid cooling.

EARTHENWARE. Fired ceramic, characterized by predominant crystalline or crypto-crystalline phases, minor vitreous phase, presence of both closed and open pores, thus being permeable to fluids.

FETTLING. Removing undesired forming marks from vessels before firing; also removing excess glaze before firing.

FIREBOX. Enclosed section of a kiln where fuel is burned.

FIRECLAY. Refractory clay; clay which can withstand high temperature without vitrification. See VITREOUS.

FIREMOUTH. Main opening giving access for air and fuel into the firebox; the primary stokehole.

FIRING. Heating pottery to a temperature at least high enough to cause permanent destruction of clay minerals; rendering pottery hard and durable by heating; heating and cooling of a kiln.

FIRING LOSSES. Number of vessels damaged during firing, expressed as a percentage of total number of vessels in the firing.

FLAME THROAT. Opening through which flame enters the chamber of a kiln.

FLUE. An opening or passage within a kiln for hot gases.

FRIT. A mixture of glaze materials which has been fused, to form glass by heating, usually to render them insoluble or nontoxic, later to be ground and added to the glaze batch.

HAND-SORTING. Removing unwanted minerals, particles of grit, etc., by hand rather than mechanical methods, from a raw material that is to be used in a pottery body, glaze, slip, etc.

HOOKAH. See detailed definition and variations under *cilam;* the complete tobacco smoking device.

KAFIR. Term used by the Muslims to refer to "infidels" inhabiting the general Chitral region before the 1890s. It is still applied

to the remaining ethnic group that has not been converted to Islam.

KNEADING. Mixing plastic clay or body to distribute evenly minerals, organic materials, and water throughout the mass, and to eliminate air pockets or voids.

kumhār. In a general sense the term means "a maker of red earthenware pottery; a maker of vessels," as opposed to the term "*kashīgar*," which means "a decorator of glazed ware." Normally all the potters in Pakistan learn their trade from their fathers and the craft is hereditary. Some potters will learn from someone else but would still be referred to as *kumhār* in the Panjabi language. The equivalent word in Pashto is *kulāl*. Essentially both words literally mean "potter" and coincidentally most potters inherit and learn the craft from their fathers, so it also has this additional "hereditary" connotation in most cases.

LEATHER HARD. Intermediate stage of drying a clay or body where plasticity is minimal but the water content is still sufficient to allow some working processes. Stage between plastic clay and bone dry.

MAUND. Pakistani unit of weight, which varies in different areas; equivalent to between 36 and 50 kg.

NEUTRAL. Atmosphere during firing when the air/fuel ratio is optimum, with neither an excess of air (oxidizing) nor fuel (reducing).

NONPLASTICS. Minerals that exhibit no plasticity, added as temper to a clay body to modify its working and firing properties.

OXIDIZING. Stages during firing when air is being supplied in excess of the amount required to fully combust the fuel.

PADDLE. Tool used in conjunction with anvil to form or change the profile of leather-hard vessels; sometimes called a beater.

PAISA. Equals $1/100$ of a rupee. Rupee is the basic unit of currency where 100 paisa equal 1 rupee.

PASTILLE. A small ball or cone of clay pushed onto the side of a vessel and flattened out to a thin disc.

PIGMENT. Material, generally a mixture of minerals, which may be painted onto pottery vessels to give a colored or contrasting decoration when fired.

PINCHING. Technique of hand-building pottery vessels, by squeezing clay to shape, usually between fingers and thumb.

PIT-WHEEL. Type of potter's wheel common in Pakistan, on which the potter supplies momentum by kicking a flywheel, and forms vessels on a separate disc, the wheelhead. So-called because the assembly is placed in a pit excavated below ground level.

PLASTIC CLAY. Clay that may be transformed into a new shape and will retain the new shape without tearing or breaking.

POLISHING. Smoothing the surface of a leather-hard vessel with a smooth, hard object to give a very smooth, lustrous surface, finer and more complete than a burnished surface. See BURNISHING.

PREHEATING. Heating vessels prior to setting for firing, to remove all remaining free moisture.

PROPS. Fired clay supports used to set vessels in a kiln; also used to support shelves or batts where these are in use.

PURDAH. The custom of requiring women to wear a veil or garment to hide the face.

QUERN. A primitive mill for grinding, commonly of grain but also of ceramic materials, consisting of two circular stones, the upper turned by hand.

REDUCING. Oxygen supply is insufficient to fully combust the fuel, characterized by the presence of carbon monoxide in the combustion products.

RESIDUAL CLAY. Clay weathered in situ; clay found in various stages of weathering with the parent rock from which it has formed.

SAGGER. A container made of fireclay in which delicate ceramic pieces are placed while being fired.

SEER. Pakistani unit of weight approximately equivalent to one kilogram.

SETTER. Fired ceramic piece used to support ware in a kiln. Also one who sets a kiln.

SETTING. Placing ceramic ware in a kiln before firing.

SINGLE WHEEL. Type of potter's wheel in which a single disc acts as both working surface and flywheel; for THROWING and TURNING.

SLAKING. Adding water to dry or semi-dry clay in order to cause lumps of clay to break up, so the clay may be evenly mixed for working.

SLIP. Fluid suspension of clay or clay body in water. Also used as a nonvitreous coating applied to a clay vessel.

SLURRY. Thick clay/water suspension (slip-like) resulting from forming operations such as throwing; the material which accumulates on the potter's hands.

SPALLING. Flaking or lifting off of areas of the surface of a fired ceramic piece; primarily due to uneven expansion of different minerals during heating and cooling operations, or to uneven temperatures throughout the piece.

SPYHOLE. Opening in a kiln, usually with a removable bung, through which ware may be observed during firing.

STILTS. Setters used for setting glazed ware, with a number of fine points, usually three, on which the glazed piece can rest, causing minimal damage to the glazed piece resulting from fusion of glaze to setter.

STOKEHOLE. Opening in the structure of a kiln through which fuel is placed. See FIREMOUTH.

TEMPER. Organic or mineral material blended with clay to improve its working and/or firing properties.

THROWING. Forming vessels on the potter's wheel by applying pressure to plastic clay with the hands.

THROWING OFF HUMP. Throwing a series of small vessels from a single large lump of clay onto the potter's wheel, by alternately centering, throwing, and cutting off only a small portion at the top of the lump until the clay has all been used.

topī. The pottery bowl for the tobacco in a smoking device known as a hookah or *cilam*. See "*cilam*."

TRANSPARENT GLAZE. A glaze, which may be colored or clear, through which the underlying slips, pigments, or glazes are visible. By contrast, a nontransparent glaze is opaque.

TURNING. Removing the excess clay from a leather-hard vessel by shaving with a sharp-edged tool as the vessel revolves on the potter's wheel, and refining the shape of the vessel.

TURNTABLE (synonym: tournette). A disc that can be slowly revolved by hand and act as a base to support a vessel being formed.

UPDRAFT KILN. Kiln in which the chamber is directly above the firebox so that the flame travels upwards through the kiln, as opposed to cross-draft or down-draft kilns, which are generally more efficient.

VITREOUS. Containing fused or glassy material.

WASTE CLAY. Unfired body clay accumulated as a by-product of forming operations, which is collected for recycling.

WASTERS. Reject vessels damaged during the manufacturing process, particularly in firing; also sherds from vessels damaged in firing.

WORKING CONSISTENCY. The optimum state of plasticity of plastic clay, where the moisture (water content as percentage by weight) has been adjusted so the clay is neither too soft nor too hard for the forming technique for which it is intended.

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Plates



PLATE 1.—Tools and equipment used by the potter Noor Khan, Bomboret Valley, NWFP: *a*, turntable, viewed from below; *b*, top view of turntable (average diameter 61 cm); *c*, sieve, pierced leather stretched over wooden frame (average diameter 37 cm); *d*, iron dish used in clay preparation (diameter 47 cm); *e*, wooden (deodar) paddles, large 40 cm long, small 37 cm long; *f*, *g*, preparing socket in wooden base for turntable.



PLATE 2.—Materials gathering and preparation, Bomboret Valley, NWFP: *a*, general view of clay-digging site; *b*, digging clay and weathered slate fragments; *c*, breaking up lumps of clay with a wooden pestle; *d*, sieving clay; *e*, selecting quartz pebbles from bed of Bomboret River; *f*, crushing quartz using a stone as a hammer, *g*, adding water to clay in a hollowed pile; *h*, rough-kneading body.



PLATE 3.—Stages in forming a water jar, Bomboret Valley, NWFP: *a*, flattening clay for base of vessel on turntable; *b*, raising edges; *c*, thinning lower wall by pinching; *d*, *e*, refining and smoothing lower wall; *f*, *g*, further thinning lower wall with beater (note that no anvil is used); *h*, trimming top ledge of lower wall; *i*, forming coil; *j*, *k*, bonding coil to top ledge of lower wall of vessel.



PLATE 4.—Stages in forming a cooking pot, Bomboret Valley, NWFP: *a*, final shaping of walls with beater; *b*, refining shape of rim with small beater; *c*, applying impressed decoration; *d*, beating out base of vessel with paddle, stone anvil inside; *e*, smoothing beaten base of vessel; *f*, wooden paddle and river-pebble anvil (vessel in this photograph is semicompleted water jar).

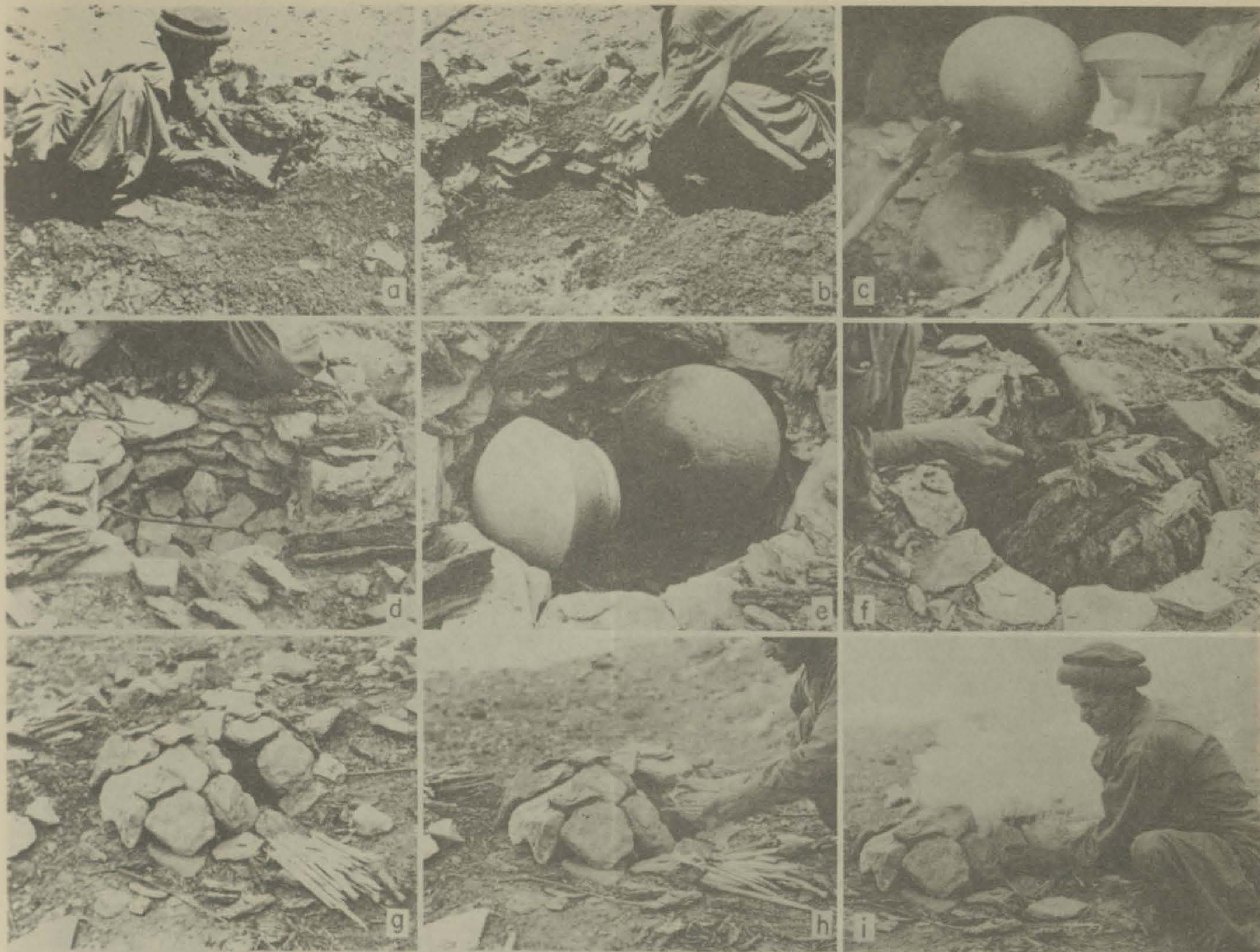


PLATE 5.—Construction and firing of a pit-kiln, Bomboret Valley, NWFP: *a*, excavating hole for pit-kiln; *b*, lining the hole with pieces of slate; *c*, preheating vessels over a fireplace in blacksmith's shop; *d*, pit-kiln, slate-lined; *e*, vessels placed on bark fuel in kiln; *f*, further bark fuel packed around vessels; *g*, vessels and fuel covered with slate; *h*, igniting the fuel with kindling; *i*, sealing the kiln completely with slate after fuel starts to burn.

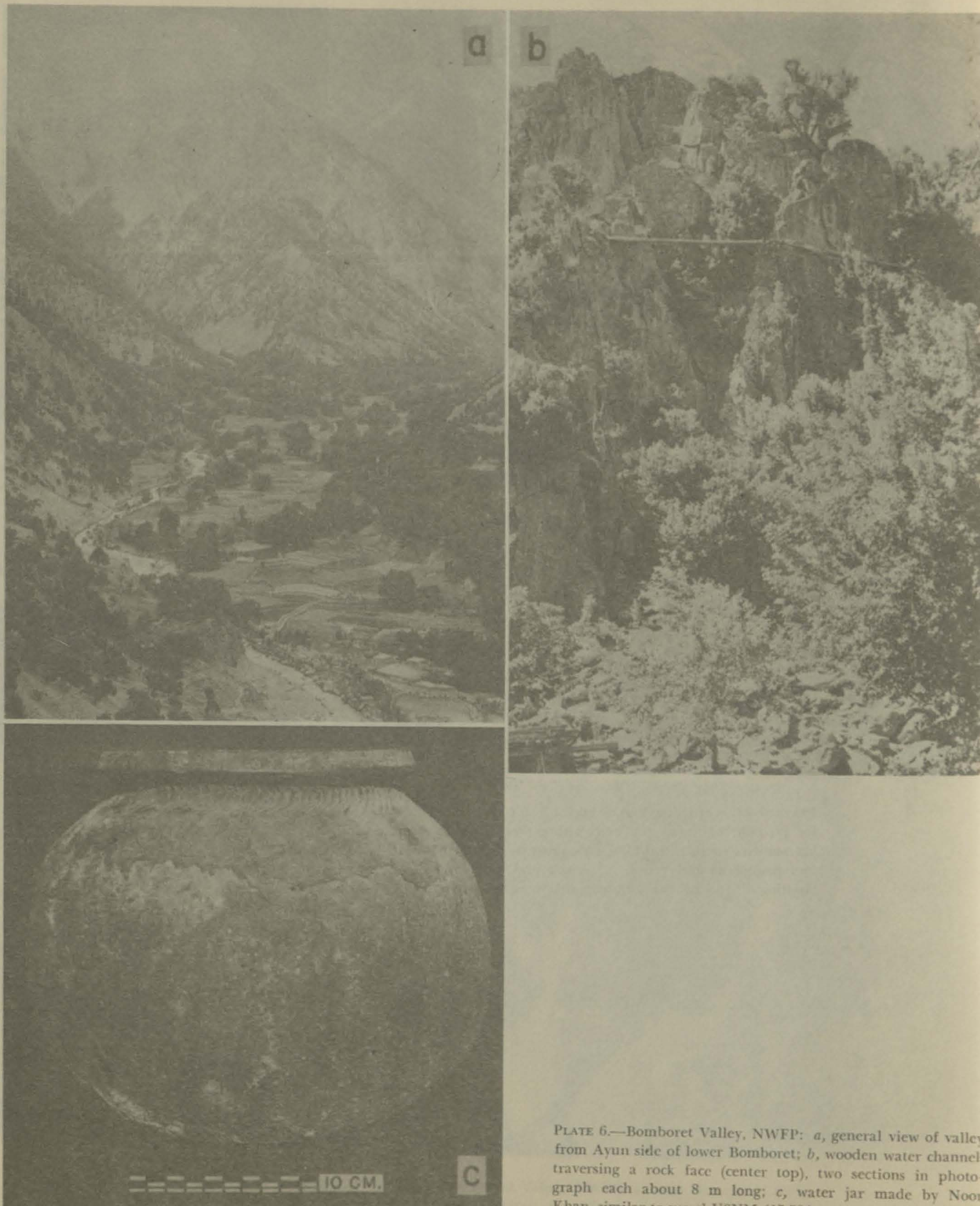
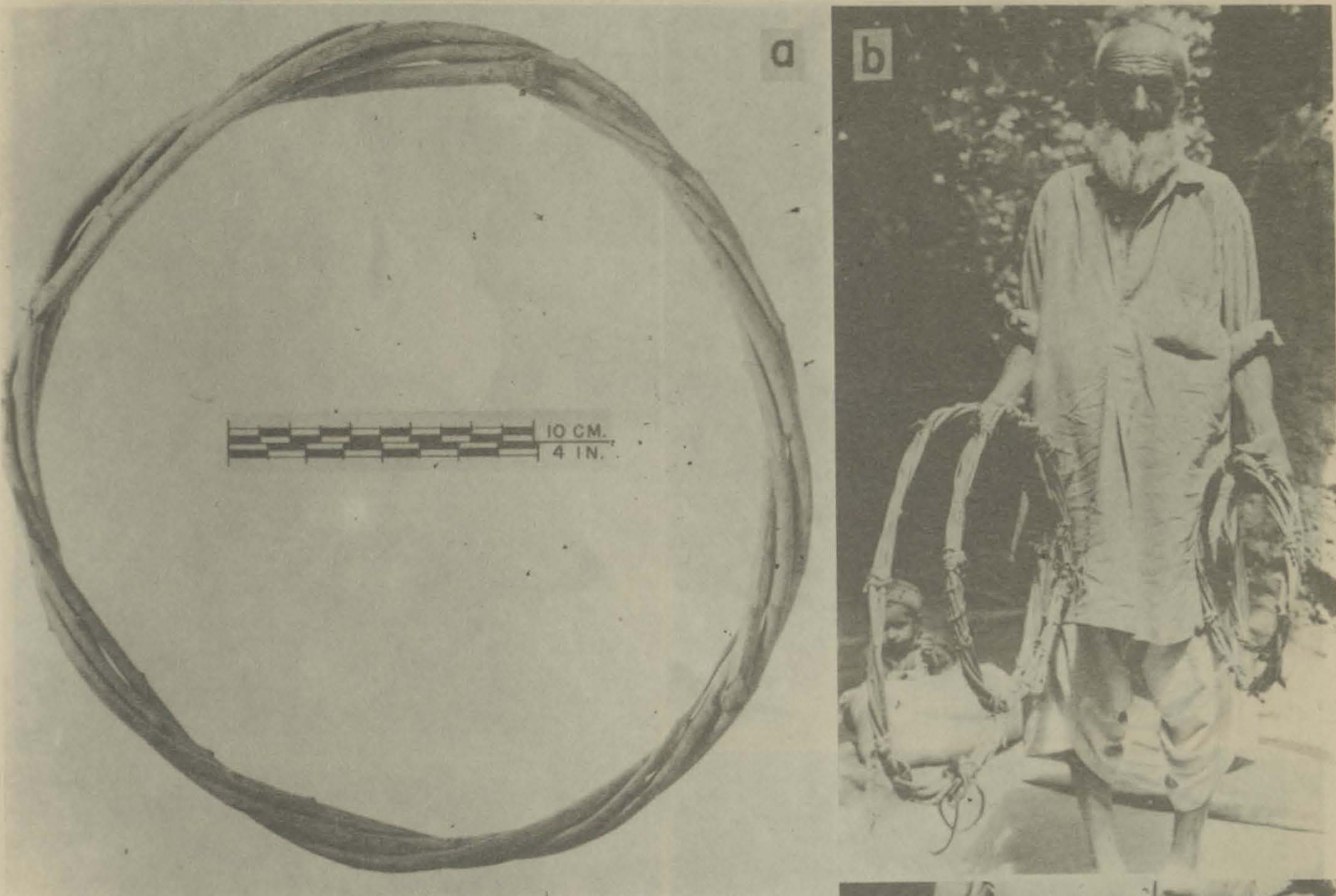


PLATE 6.—Bomboret Valley, NWFP: *a*, general view of valley from Ayun side of lower Bomboret; *b*, wooden water channels traversing a rock face (center top), two sections in photograph each about 8 m long; *c*, water jar made by Noor Khan, similar to vessel USNM 417,524.



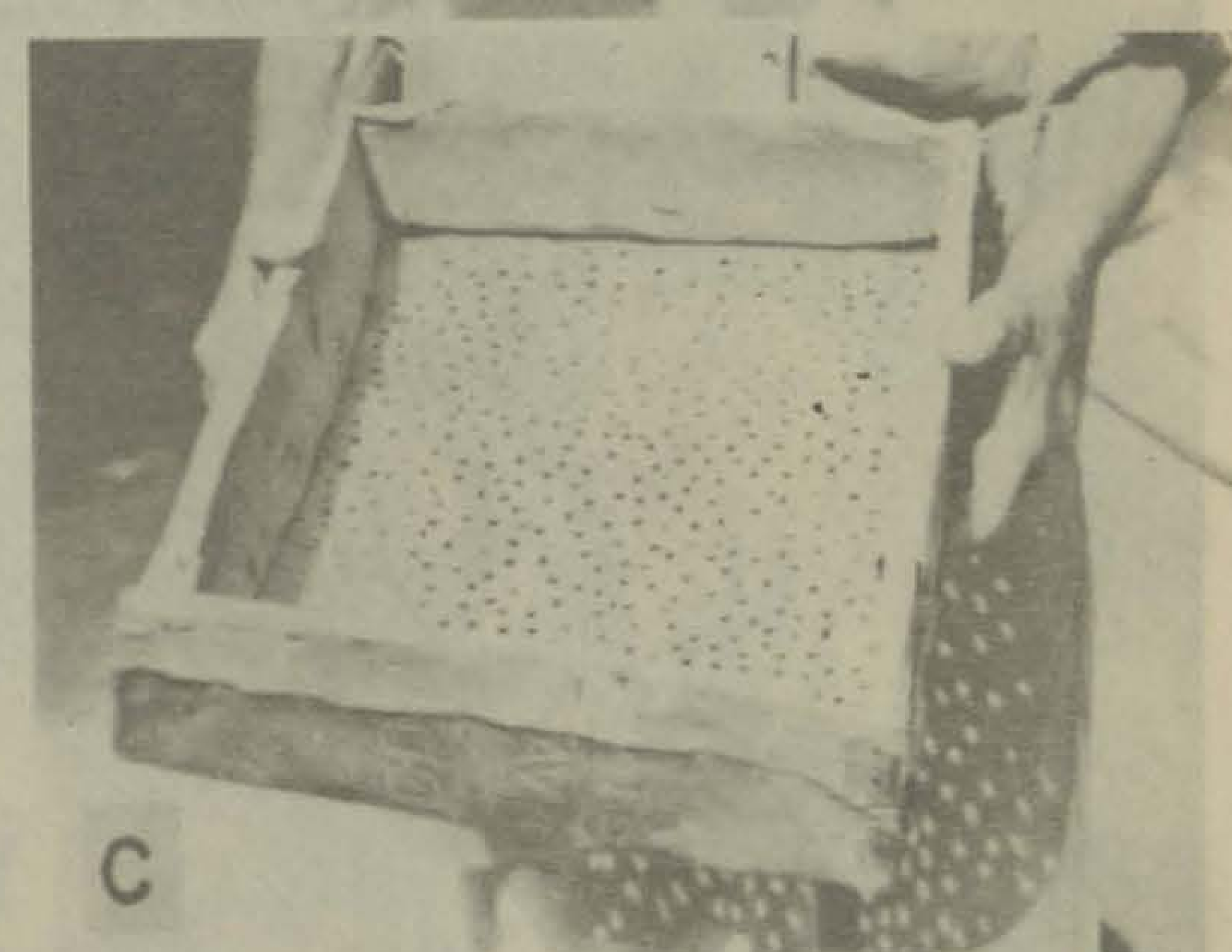


PLATE 7.—Tools and equipment used by the potter Mehrab Shah, Seen, Chitral, NWFP: *a*, twisted willow twig hoop, USNM 417,418; *b*, Mehrab Shah with twisted willow twig hoops used in forming vessels; *c*, *d*, sieve for clay, 29 by 47 cm, punched sheet metal on wooden frame; *e*, clay preparation dish, wood, maximum dimensions 81 by 64 cm.



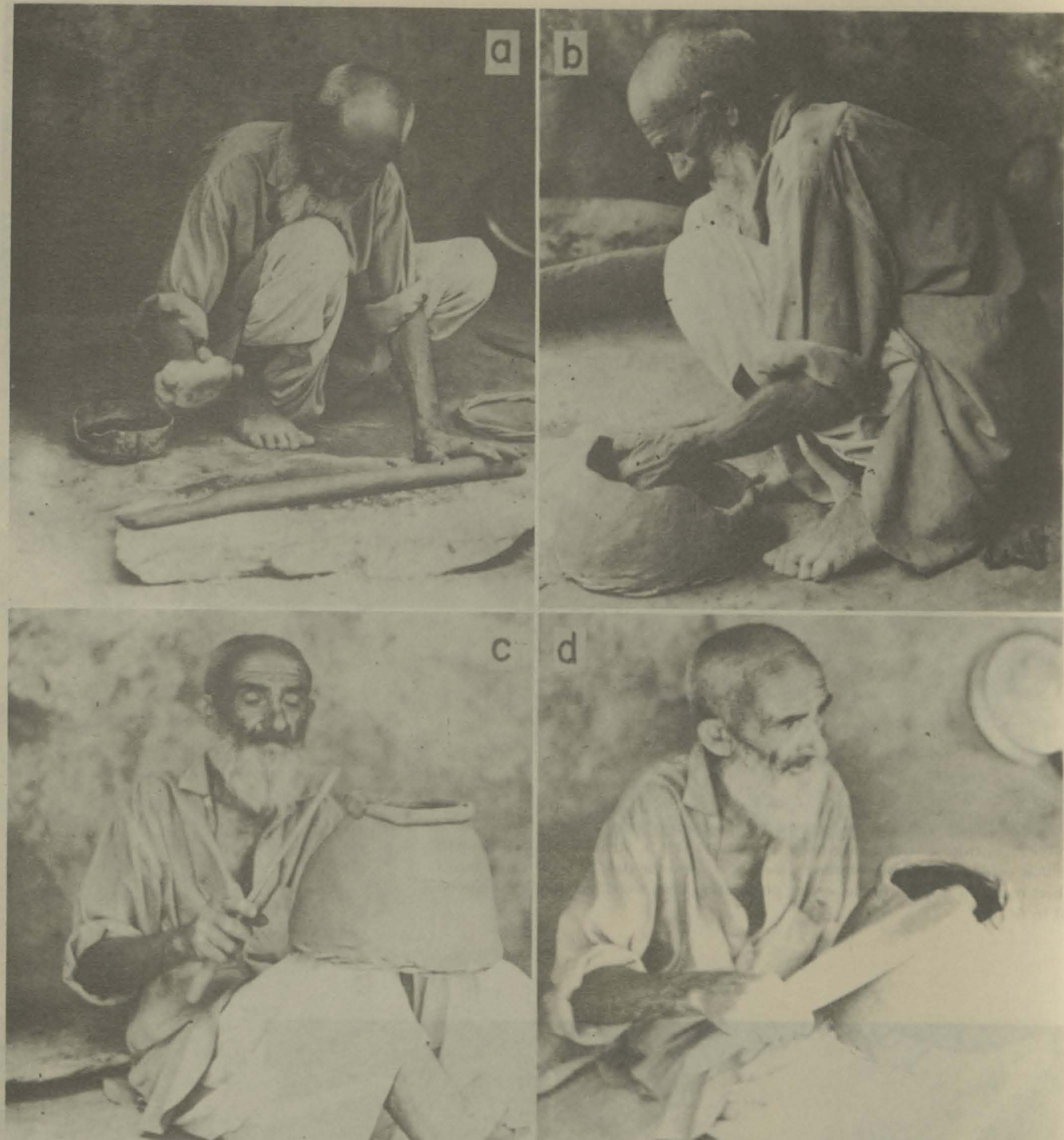




PLATE 8.—Formation of a storage pot, Seen, Chitral, NWFP: *a*, beating out a coil; *b*, with coil bonded to willow hoop, thinning the coil to form the base of the vessel; *c*, *d*, adding a further coil and beating out shape of the base; *e*, additional coil joined to outside rim of semicompleted base.

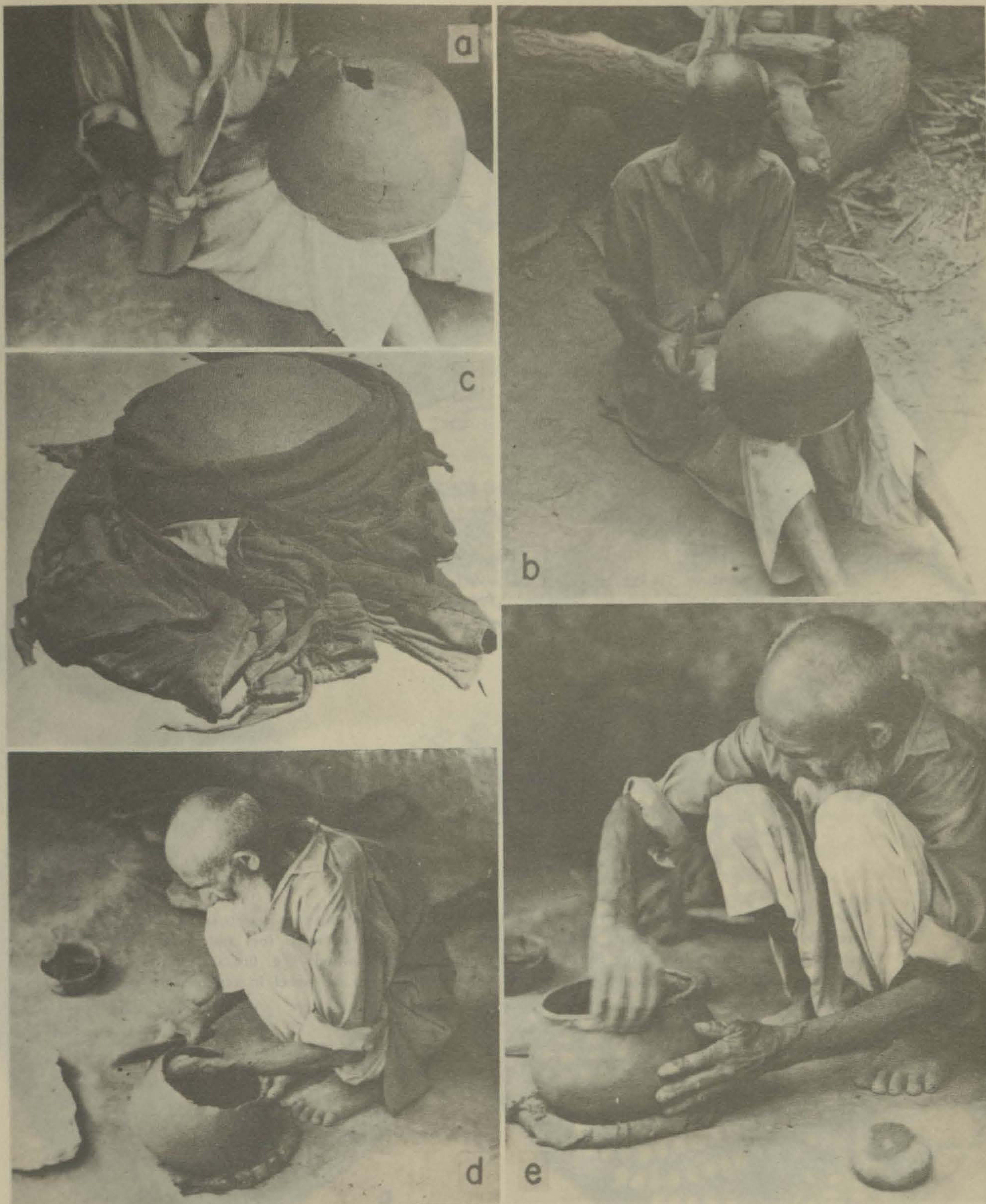


PLATE 9.—Formation of a storage pot, Seen, Chitral, NWFP: *a*, closing the base of vessel with beater and anvil; *b*, completed base; *c*, drying the base, with wet cloth wrapped around rim to retard its drying; *d*, hoop removed from rim; beating upper walls; *e*, everting the rim with fingers.



PLATE 10.—Bonfire firing of pottery, Seen, Chitral, NWFP: *a*, boy carrying vessels to the firing area; *b*, depression where setting is placed; *c*, beginning setting of wood fuel and vessels; *d*, setting semicomplete; *e*, lighting the fire using bushes to ignite wood; *f*, *g*, fire at beginning, and near end, of firing; *h*, vessels after firing (note spalled area on vessel in center right of photograph).



PLATE 11.—Two milk pitchers from Chitral, NWFP: *a*, USNM 417,417, made by Mehrab Shah of Seen, Chitral; *b*, USNM 417,413, made by potter from Madak, Chitral (note mold marks near base).

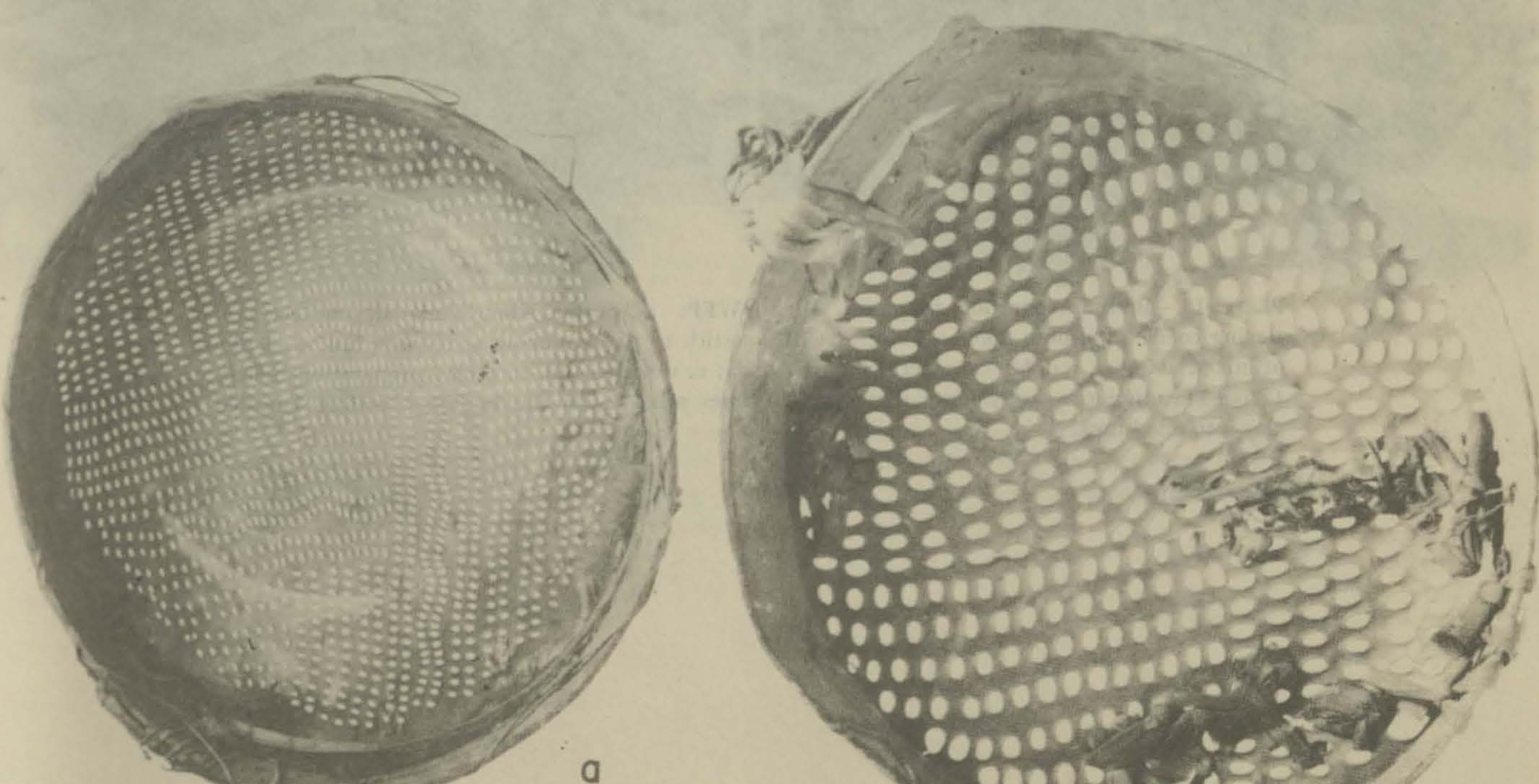


PLATE 12.—Sieves used by potter Khan Zada, Dir, NWFP, of pierced leather, tied to a wooden frame with leather thong: *a*, USNM 417,609; *b*, USNM 417610.



PLATE 13.—Body preparation of vessel, Dir, NWFP: *a*, potter Khan Zada sieving clay; *b*, sieving coarse sand onto floor so wet clay will not stick to it; *c*, pouring water into hollowed pile of mixed clays; *d*, roughly compacting plastic body; *e*, sieving sand onto clay preparation bench; *f*, foot-kneading clay body (note that sand becomes mixed into the body); *g*, rolling kneaded clay into one lump.



PLATE 14.—Forming vessels on the pit-wheel, Dir, NWFP: *a*, placing fired clay base mold on cloth pad on the wheelhead; *b*, mold on wheel (base of vessel has been formed on sand, right back); *c*, forming coil (note clay for base of vessel to be formed has been placed in base-mold); *d*, throwing upper walls of a vessel; *e*, using smoothing tool to refine walls of vessel; *f*, trimming excess clay from base of vessel, at junction with mold.



PLATE 15.—Forming vessels on the pit-wheel, Dir, NWFP: *a–d*, stages in throwing the upper walls and rim of a water pot (note use of smoothing tool in *d*). Forming a lid for a cooking pot, Dir, NWFP: *e*, forming the lid; *f*, trimming off excess clay; *g*, forming the knob.



PLATE 16.—Using paddle and anvil to complete the base of water pots, Dir, NWFP: *a*, trimming off excess clay with a knife before beginning beating; *b*, forming with paddle and anvil; *c*, completed form of waterpot; *d*, cracks appearing in base of vessel during beating are repaired with plastic clay which is blended into the form by further beating.



PLATE 17.—Setting and firing the kiln, Dir, NWFP: *a*, Khan Zada standing in the kiln; *b*, setting first layer of dung fuel; *c*, placing first layer of vessels; *d*, women preparing fuel; *e*, filling interstices between vessels with small lumps of dung fuel; *f*, placing final layer of vessels; *g*, asking for Allah's blessing of the setting; *h*, view of kiln and setting after firing; *i*, removing fired vessels from the kiln.



PLATE 18.—Forming vessels on the pit-wheel, Alam Ganj, Swat, NWFP: *a*, potter Amir forms a clay disc for the base of a vessel; *b*, the clay disc is placed in a fired clay mold on the wheel, and a coil of clay bonded around the rim of the disc; *c*, centering the coil; *d*, forming the walls of the vessel by throwing and thinning the coil.



PLATE 19.—Slip application and kilns, Swat, NWFP: *a,* applying red slip to a water pot with a cloth saturated with the slip; *b,* open kiln, village Chamthale, upper Swat Valley (height of walls approximately 1 m); *c, d,* two views of open kiln, Alam Ganj, Swat (height of walls 1.5 m, lower front wall 0.8 m).

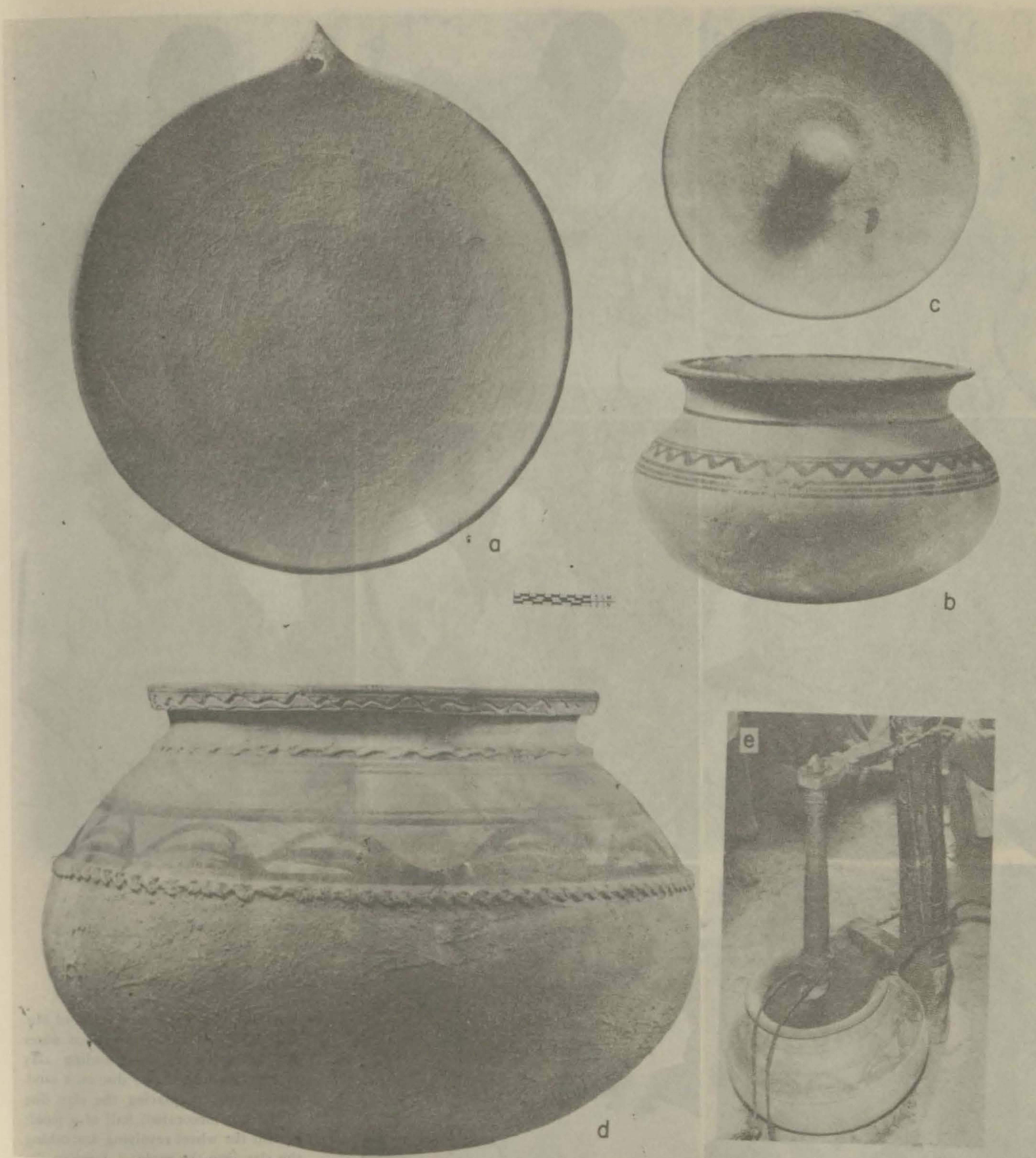


PLATE 20.—Unglazed earthenware from Swat, NWFP: *a*, dish for cooking *capāṭī*, decoration in incised, combed, bands, from Alam Ganj (USNM 417,319); *b*, cooking pot for rice from Alam Ganj (USNM 417,318-A); *c*, cooking pot lid, decorated with painted black bands (USNM 417,318-B); *d*, butter churn, incised, painted and applied decoration, Deolai, Swat (USNM 412,686); *e*, same butter churn, in use (the paddle is revolved by pulling on the rope, lower left, which passes around a shaft, center left, upright, attached to the blades of the paddle).

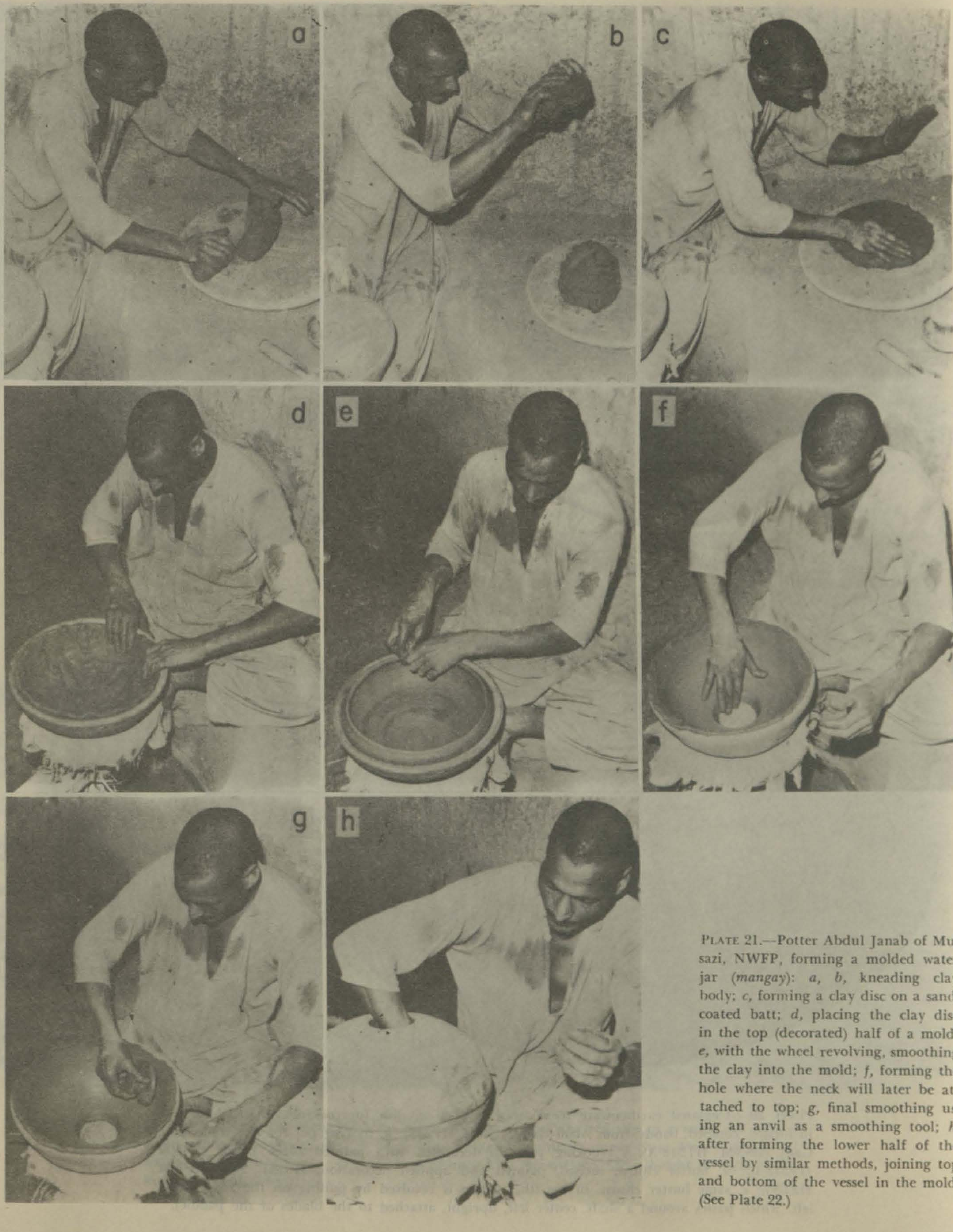


PLATE 21.—Potter Abdul Janab of Musazi, NWFP, forming a molded water jar (*mangay*): *a*, *b*, kneading clay body; *c*, forming a clay disc on a sand-coated batt; *d*, placing the clay disc in the top (decorated) half of a mold; *e*, with the wheel revolving, smoothing the clay into the mold; *f*, forming the hole where the neck will later be attached to top; *g*, final smoothing using an anvil as a smoothing tool; *h*, after forming the lower half of the vessel by similar methods, joining top and bottom of the vessel in the mold. (See Plate 22.)



PLATE 22.—Potter Abdul Janab of Musazi, NWFP, form a molded water jar (*mangay*) (continued): *a*, removing base mold to allow the base to dry; *b*, after base has dried, base mold is replaced and top mold removed to allow top to dry; *c*, typical impressed decoration in top mold; *d*, joining a coil of clay to the vessel, around the open top; *e*, bonding the coil to the vessel; *f*, throwing the coil to form the neck and rim of the water pot.

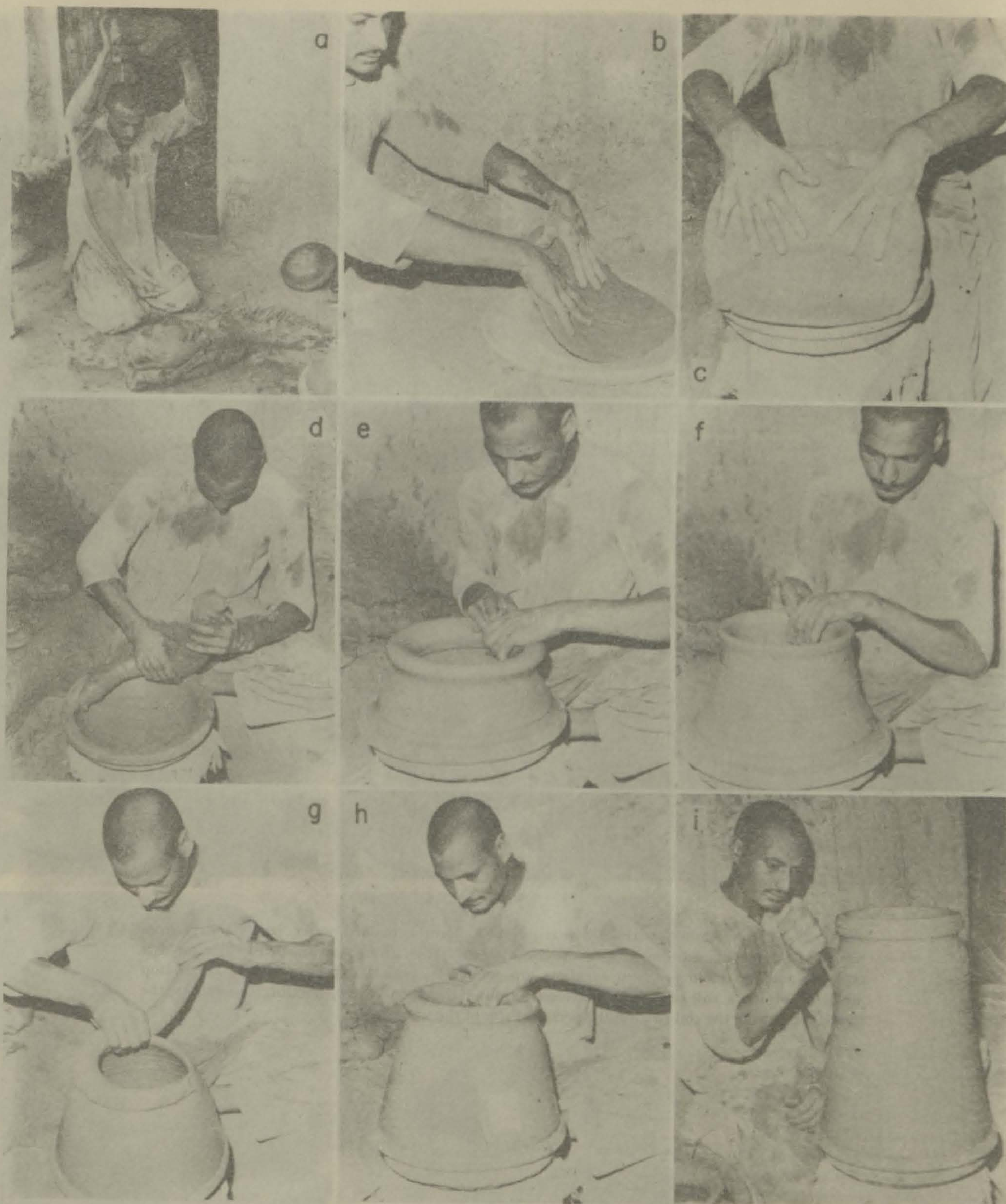


PLATE 23.—Potter Abdul Janab of Musazi, NWFP, forming a large water storage jar: *a*, kneading or wedging the clay; *b*, *c*, method of lifting a flat disc of soft clay from the batt and placing it in the base mold; *d*, joining a coil of clay to the base in the mold; *e*, *f*, throwing lower walls of vessel; *g*, *h*, joining a further coil of clay at the rim, and throwing to further increase the height of the walls; *i*, final thrown shape, the shoulder is dusted with sand. (See Plate 24.)



PLATE 24.—Potter Abdul Janab of Musazi forming a large water storage jar (continued): *a*, trimming the base of a completed water jar; *b–d*, final stages of completing the vessel; the leather hard vessel, still in the base mold (*d*) is replaced on the wheel and the form completed with paddle and anvil as the wheel slowly revolves; *e*, form receiving final smoothing; *f*, decorative band is applied to the shoulder of the water jar.



PLATE 25.—Musazi potter Abdul Janab's "tour de force," forming the largest sized water jar: *a*, two men lifting a disc of clay into the base mold; *b*, coil of clay joined to the perimeter of the smoothed base; *c*, throwing the coil to form lower wall of water jar; *d–f*, throwing further coils to increase the height of the walls (the final thrown shape is that of the vessel in Plate 23*i*, the vessel is then completed by the methods shown in Plate 24).











PLATE 26.—Water jars and kiln, Musazi, NWFP: *a*, large water jars, two on right before beating, two at left after beating; *b*, removing a completed water jar from the base mold; *c*, Abdul Janab's open kiln (Some vessels still in place from previous firing, see also Figure 7); *d*, water jars in Pabbi bazaar; *e*, Abdul Samad, guide and interpreter, with a group of Musazi water jars.



PLATE 27.—Clay deposit and pit-wheel, Kharmathu, NWFP: *a*, potter Waris Khan standing on the site where clay for the Kharmathu workshop is dug; *b*, pit-wheel assembly; *c*, view of bottom of flywheel of pit-wheel (note steel pin which locks flywheel to shaft, arrowed); *d*, close up of top bearing (note cloth packed between shaft and wooden crossmember).

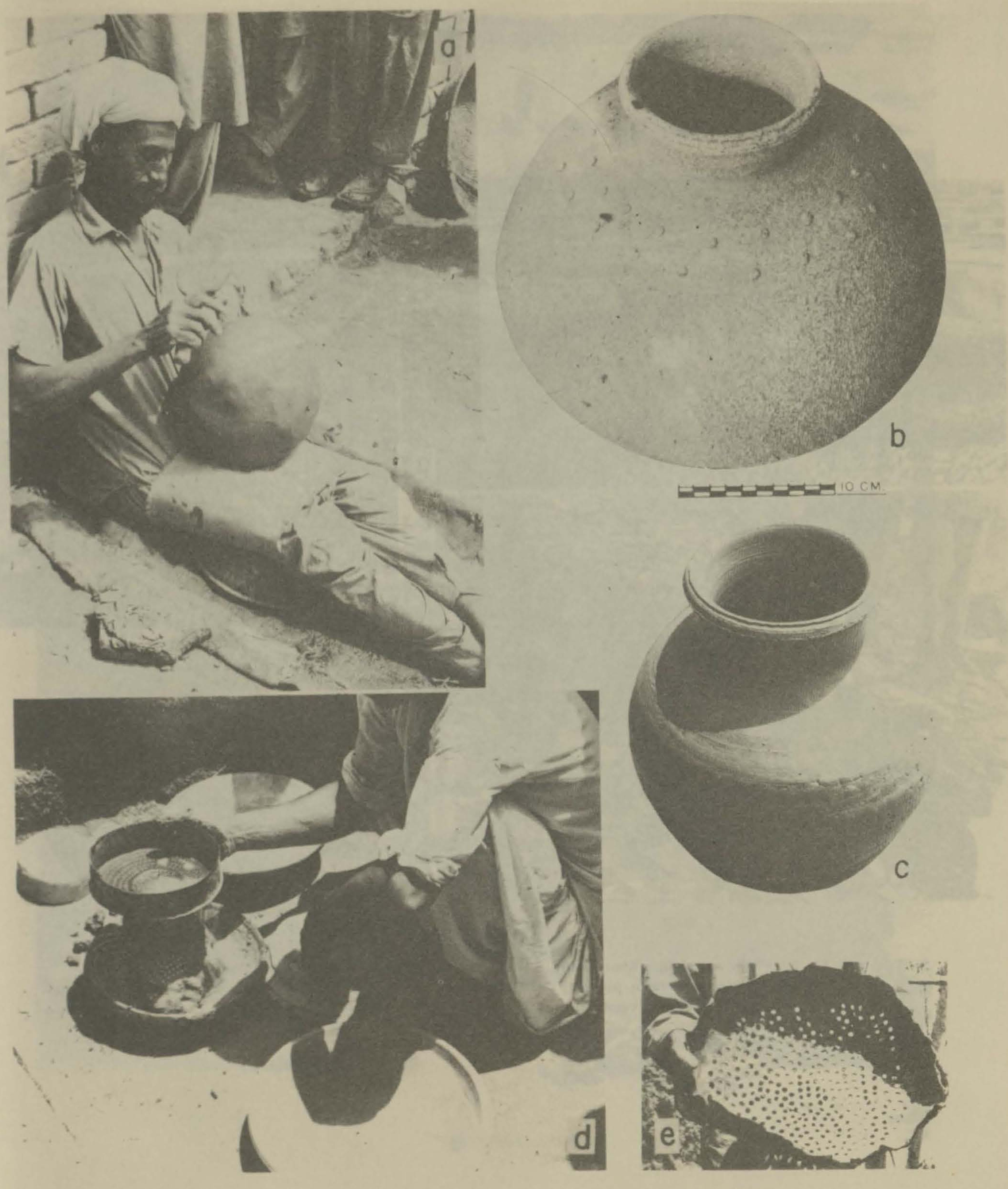


PLATE 28.—Body preparation and forming of vessel, Kharmathu, NWFP: *a*, potter Sher Zaman beating out the base of a water pot; *b*, shape of water pot *after* beating; *c*, shape of water pot *before* beating, as thrown on wheel (same scale as 28*b*; note cracks at sides of form); *d*, sieving sand for body with fine sieve; *e*, coarse sieve, made from sheetmetal, used for clay.



PLATE 29.—Kiln and firing, Kharmathu, NWFP: *a*, view of Kharmathu village from kiln site; *b*, looking uphill at an open pit-kiln, the boundary of which is indicated by the white line; *c*, sherds and debris from previous firings of the kiln site; *d*, vessel damaged through excessive vitrification in firing.

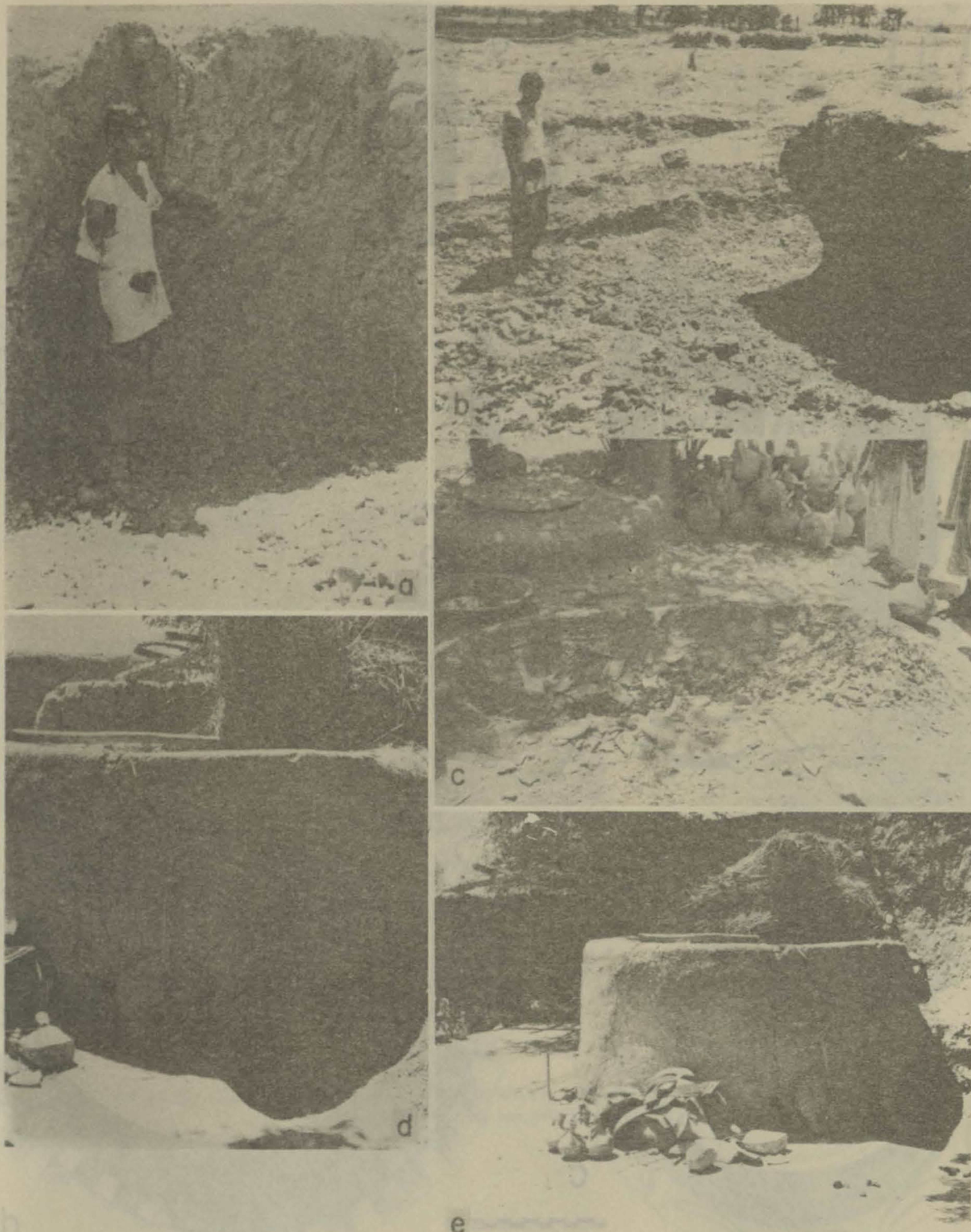


PLATE 30.—Clay deposit and kiln, Shahbaz Ahmed Khel, NWFP: *a*, potter Mir Shad indicating upper limit of usable clay in deposit (ground level is at top of photograph); *b*, general view of clay deposit; *c*, pit used for storing waste clay for recycling (in center); *d*, view of kiln, looking toward stokehole (see also Figure 11); *e*, general view of kiln (note reed fuel stacked on top of kiln).



PLATE 31.—Potter's workshop, Shahbaz Ahmed Khel, NWFP: *a*, entrance to potter's workshop (clay storage cupboard near archway); *b*, plates and dishes drying in the courtyard; entrance to courtyard top left; *c, d*, dishes, made by Mir Shad, thrown, turned, red slip and black pigment brushwork.

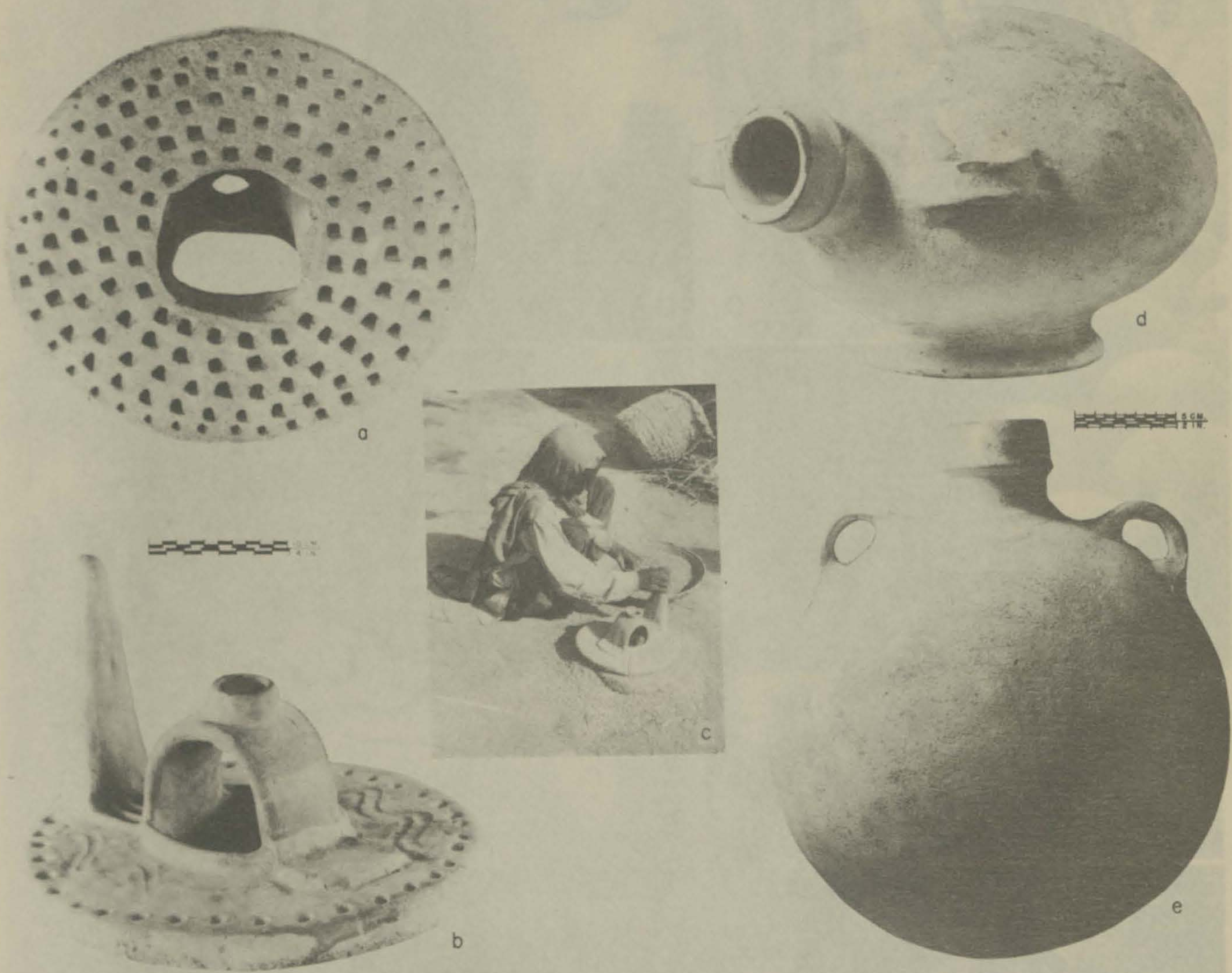
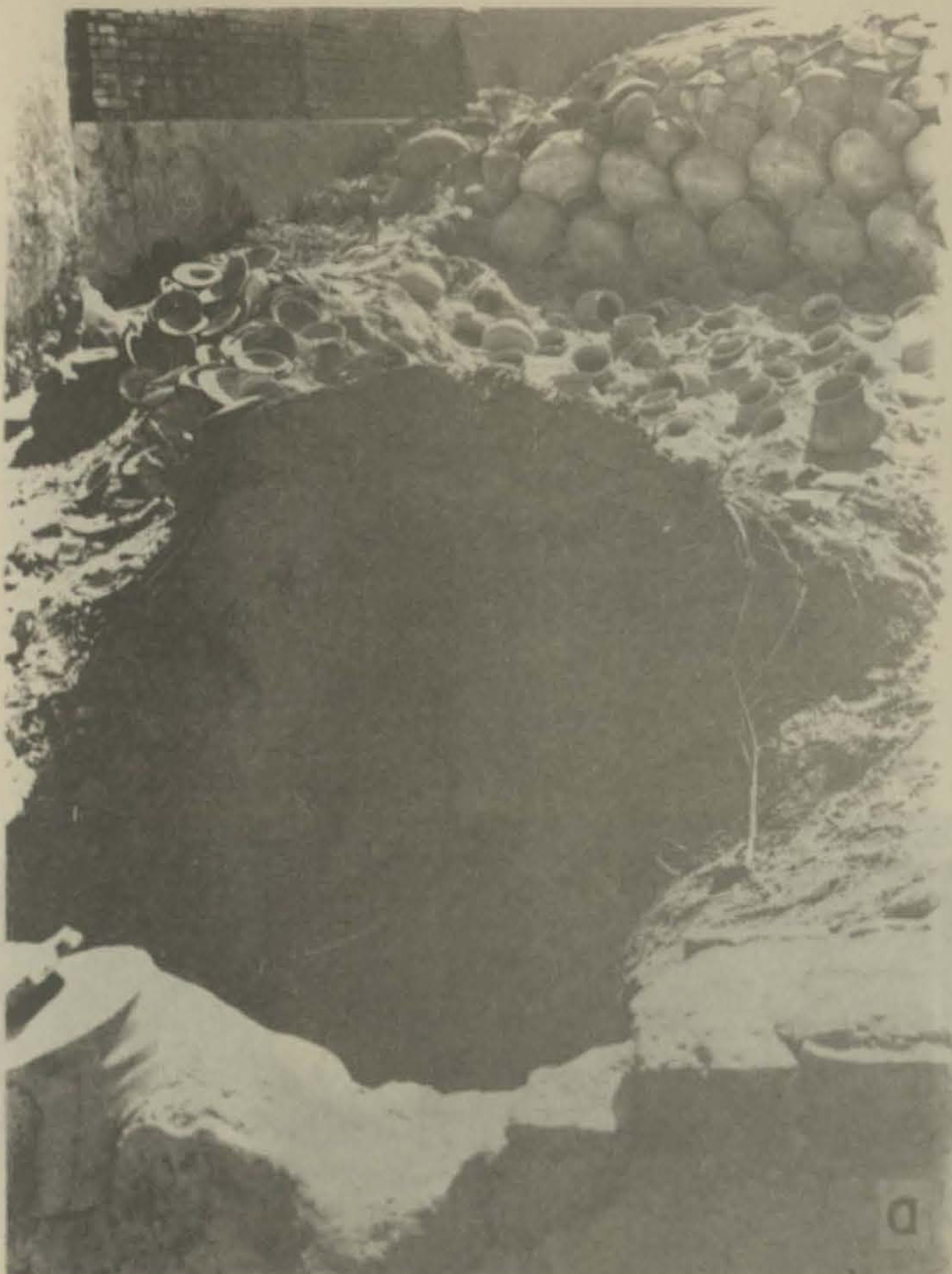


PLATE 32.—Unglazed earthenware from Nurar, NWFP: *a–c*, rice husking mill (USNM 412,570): *d, e*, two views of water carrying pot, pilgrim flask (USNM 412,568).



PLATE 33.—Forming and finishing water vessels, Dera Ismail Khan, NWFP: *a, b*, hand-kneading clay (the two pieces are torn off and clay thumped down on the center portion); *c*, pit-wheel (USNM 417,237); *d*, Mahommed Jan beating the base of a water pot, first stage; *e*, Mahommed Jan and Ghulam Hassan beating base of water pots, first stage (note that vessel rests on cloth in dish); *f*, Ghulam Hassan beating out the final shape of a water pot, with a long-handled anvil (note vessel resting in mold dish).



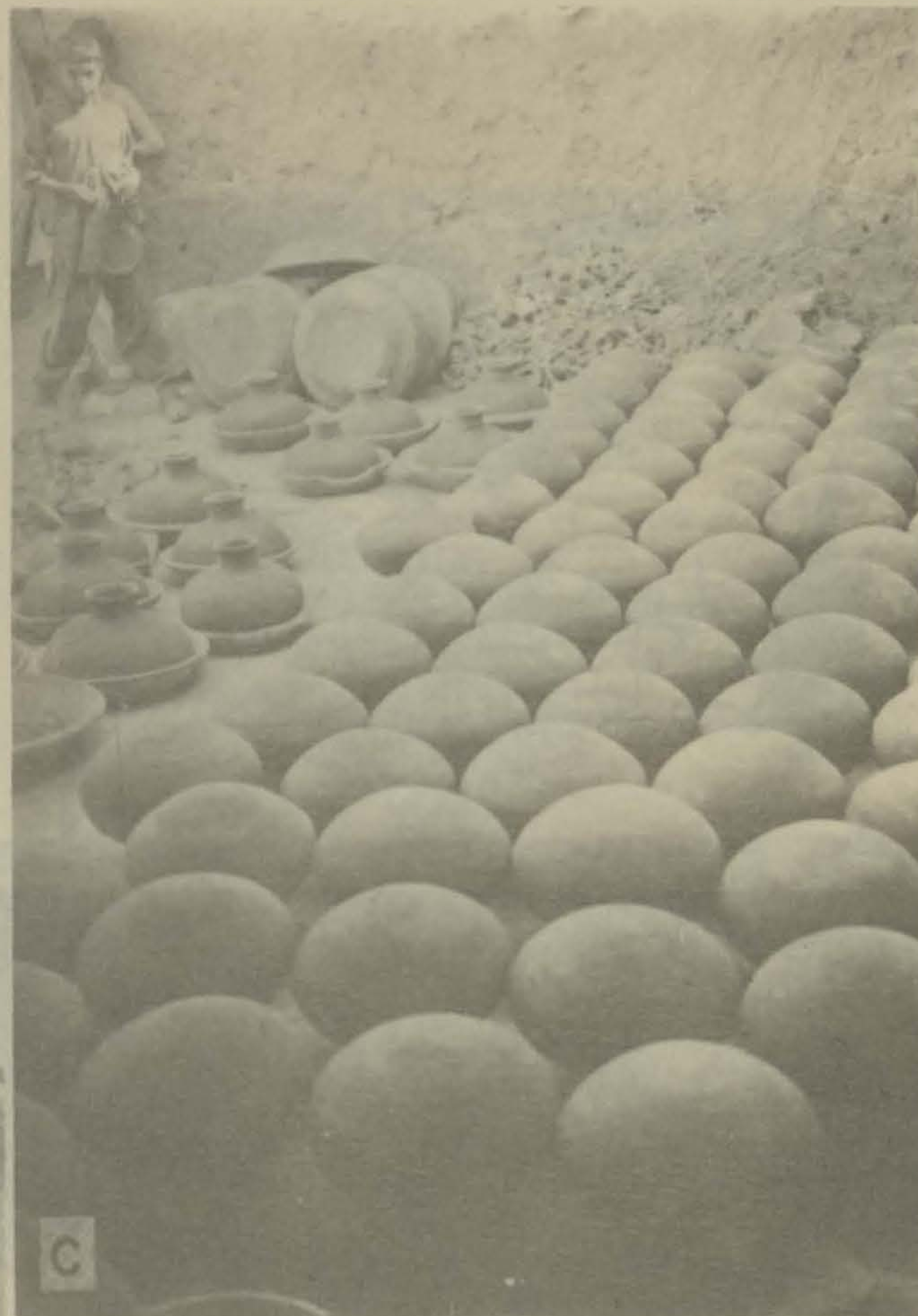




PLATE 34.—Firing, Dera Ismail Khan, NWFP: *a*, firemouth giving air access to base of setting in kiln; *b*, general view of open pit-kiln, after firing but before any vessels have been removed; *c*, water pots drying before decoration and firing.

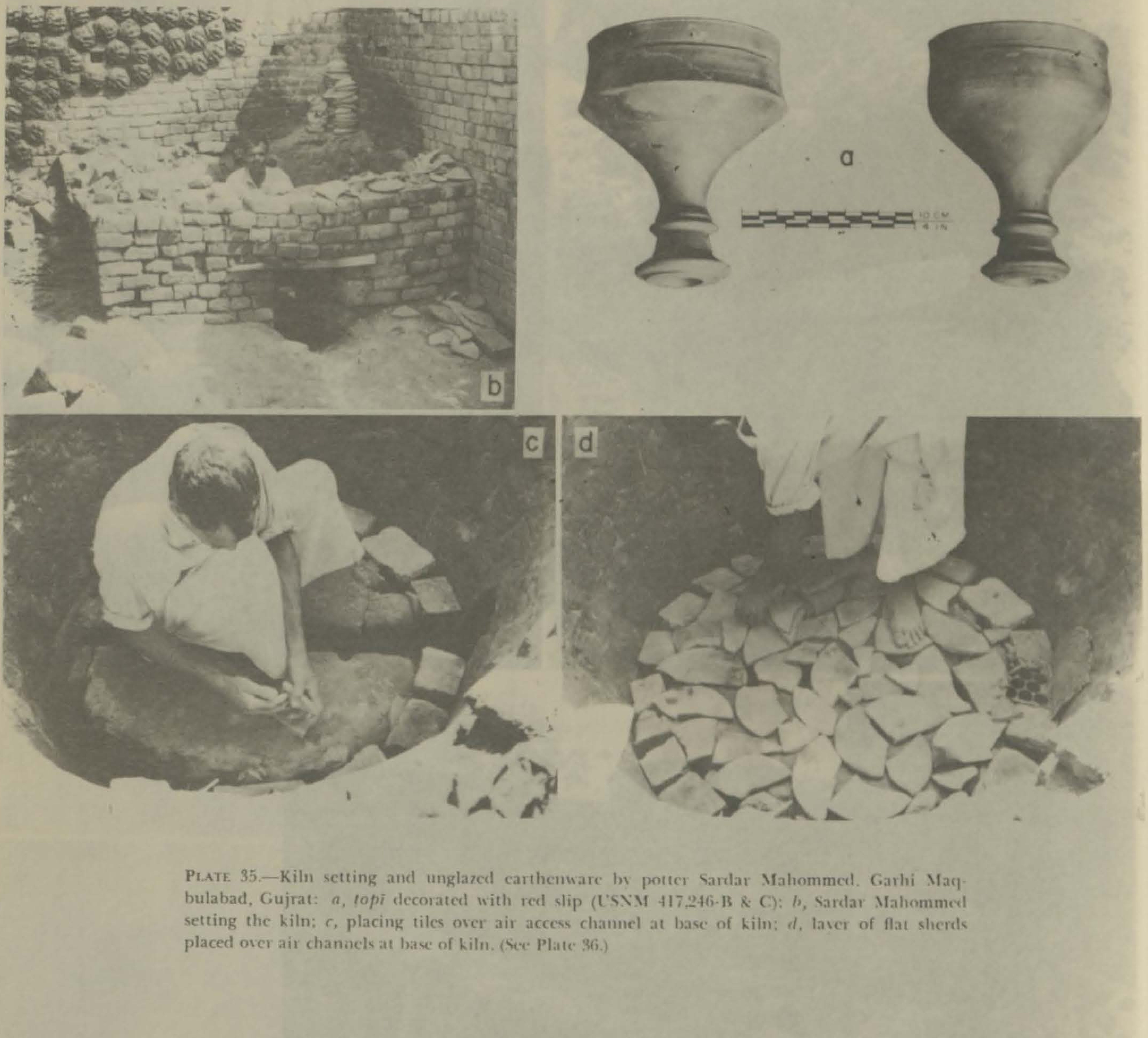


PLATE 35.—Kiln setting and unglazed earthenware by potter Sardar Mahommed, Garhi Maqbulabad, Gujrat: *a*, *ṭopī* decorated with red slip (USNM 417,246-B & C); *b*, Sardar Mahommed setting the kiln; *c*, placing tiles over air access channel at base of kiln; *d*, layer of flat sherds placed over air channels at base of kiln. (See Plate 36.)



PLATE 36.—Setting a kiln, Garhi Maqbulabad, Gujrat (continued): *a*, placing a layer of straw over the sherds; *b*, placing a layer of flat dung pieces on the straw; *c*, a layer of coarse lumps of dung placed next; *d*, setting of a layer of tobacco bowls (note plank placed across top of kiln so potter can easily reach center of setting). (See Plate 37.)





PLATE 37.—Firing and setting a kiln, Garhi Maqbulabad, Gujrat (continued): *a*, placing final layer of dung fuel to fill spaces between tobacco bowls in setting; *b*, layer of dry, then damp straw covering the setting; *c*, the kiln after firing has commenced (note almost complete absence of smoke); *d*, thin-walled bowl (USNM 417,247-B), associated with legend on Sohni and Mahinwal (Appendix 6).



PLATE 38.—Potter Abdul Majid throwing the initial form for a dish (*kunālā*), Shadiwal, Gujrat: *a*, lump of clay placed on wheel; *b*, centering the clay; *c*, opening the clay; *d*, lifting the clay (note that potter sits at side of pit, not on crossmember of wheel); *e*, final thrown form completed; *f*, cutting through base of form with thread; *g*, lifting the form from the wheel. (See Plate 39.)



PLATE 39.—Potter Ala Dita completing a dish, Shadiwal, Gujrat (continued): *a*, squeezing clay from thick sides of thrown form inwards to close the hollow base; *b*, smoothing base by beating with an anvil; *c*, hand-smoothing the dish; *d*, typical open pit-kiln at Shadiwal.



PLATE 40.—Unglazed dishes (*kunālī*), red slip, black pigment brushwork, Shadiwal, Gujrat: *a*, USNM 417,252-A; *b*, USNM 417,252-B; *c*, USNM 417,252-C.



PLATE 41.—Slips, kilns, and molds, Ahmedpur East, Panjab: *a*, applying micaceous slip to a *surāhī* by pouring; *b*, two updraught kilns in a potter's workshop (the stokehole of kiln at front, used for firing blackware, sealed with bricks and mud. Wood fuel in foreground); *c*, frontal view of orangeware kiln (stokehole bottom center; see *d*); *d*, molds used to form lids for covered dishes (lids removed from the molds in right foreground; see Plate 44*b*).



PLATE 42.—Paperfine ware, Ahmedpur East, Panjab: *a*, orangeware *surāhī*, frontal view (USNM 410,652-O); *b*, obverse of *a*; *c*, orangeware *kūzā* (USNM 417,174).

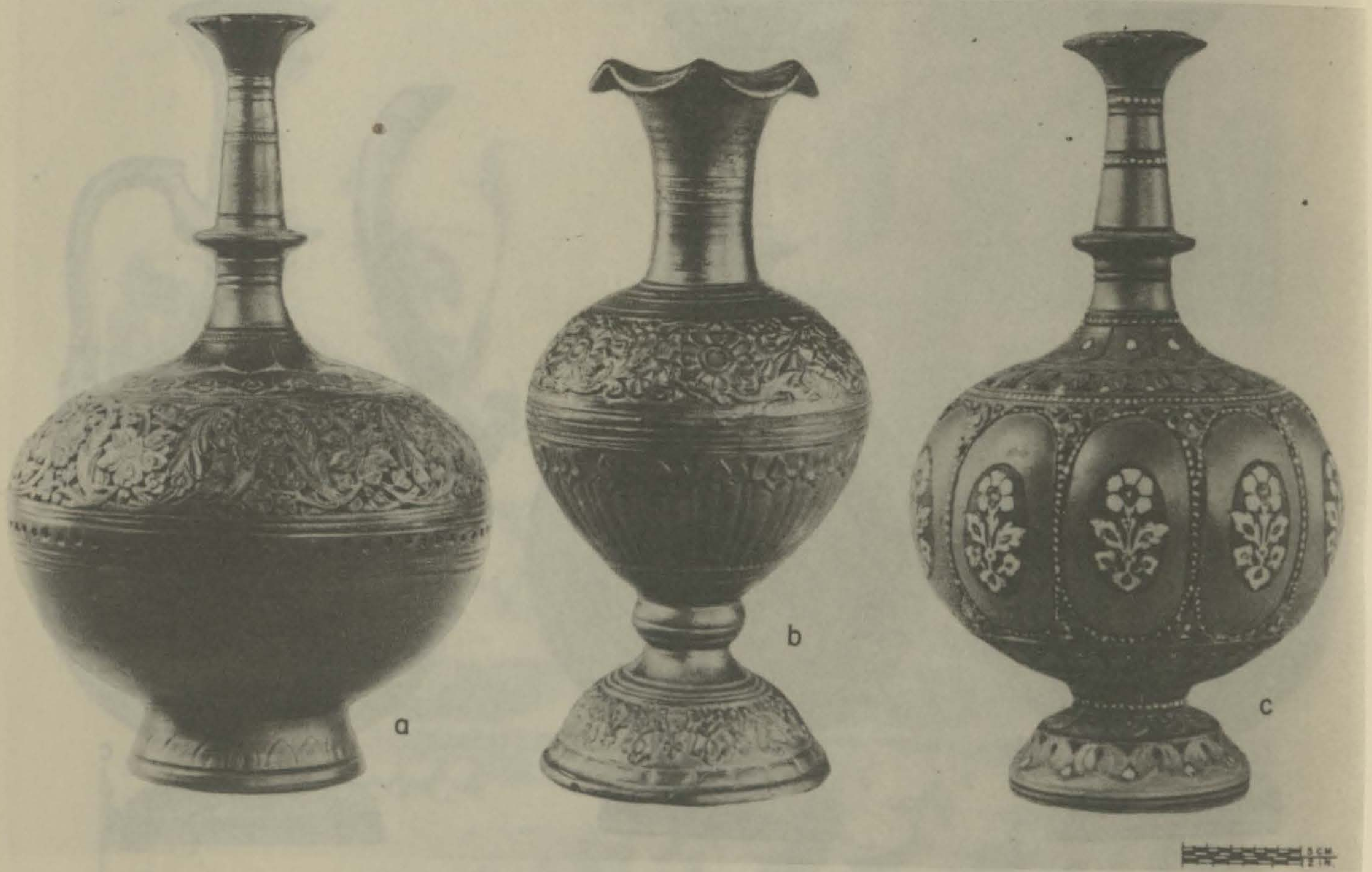


PLATE 43.—Paperfine ware, Ahmedpur East, Panjab: *a*, blackware *surāhī* (USNM 410,652-N); *b*, blackware flower vase, *guldān* (USNM 417,164); *c*, orangeware *surāhī* (USNM 417,170-A, B).



PLATE 44.—Paperfine ware, Ahmedpur East, Panjab: *a*, blackware plate or wall plaque (USNM 417,167); *b*, orangeware dish with lid, (*mukīdān*) (USNM 417,169-B); *c*, blackware flower vase (*guldān*) (USNM 417,164); *d*, pointed steel tool used for piercing decoration (*nerār*) (USNM 410,652-F).



PLATE 45.—Utilitarian domestic ware, Ahmedpur East, Panjab: *a*, dish, decorated with black, red, and white brushwork, unslipped (scale ½ of other two vessels); *b*, dish with red slip, black brushwork decoration (USNM 410,652-G); *c*, water jar with black, white, and red brushwork decoration (USNM 410,652-H).



PLATE 46.—Brickmaking in brickyard near Bannu city, NWFP: *a*, digging clay from working face of brickpit; *b*, crushing clay lumps (water is then poured on the clay to bring it to working consistency); *c*, molding bricks (an assistant prepares lumps of clay, as the molder packs clay in the mold and cuts off excess); *d*, removing the mold from a newly molded brick; *e*, general view of brickyard, molding area in background, horses carrying dry bricks to the kiln.







PLATE 47.—Making clay oven (*tanur*) in various localities: *a*, Quetta, Baluchistan, chopping vegetable fiber for use as tempering material; *b*, Quetta, mixing chopped vegetable fiber with plastic clay, used for making *tanurs*; c, Sukkur, portable *tanur* (diameter at top approximately 0.3 m); *d*, form of conventional *tanur* (height ranges from about 0.5 to 1.5 m).



PLATE 48.—Making bread (*nan*) in *tanur*: *a*, weighing dough; *b*, forming cakes of dough; *c*, placing the unbaked loaf in the *tanur* (the loaf is stuck to the side of the oven, which has glowing charcoal in the bottom); *d*, removing a baked loaf of *nan* from the *tanur* (note pile of baked *nan* on right).

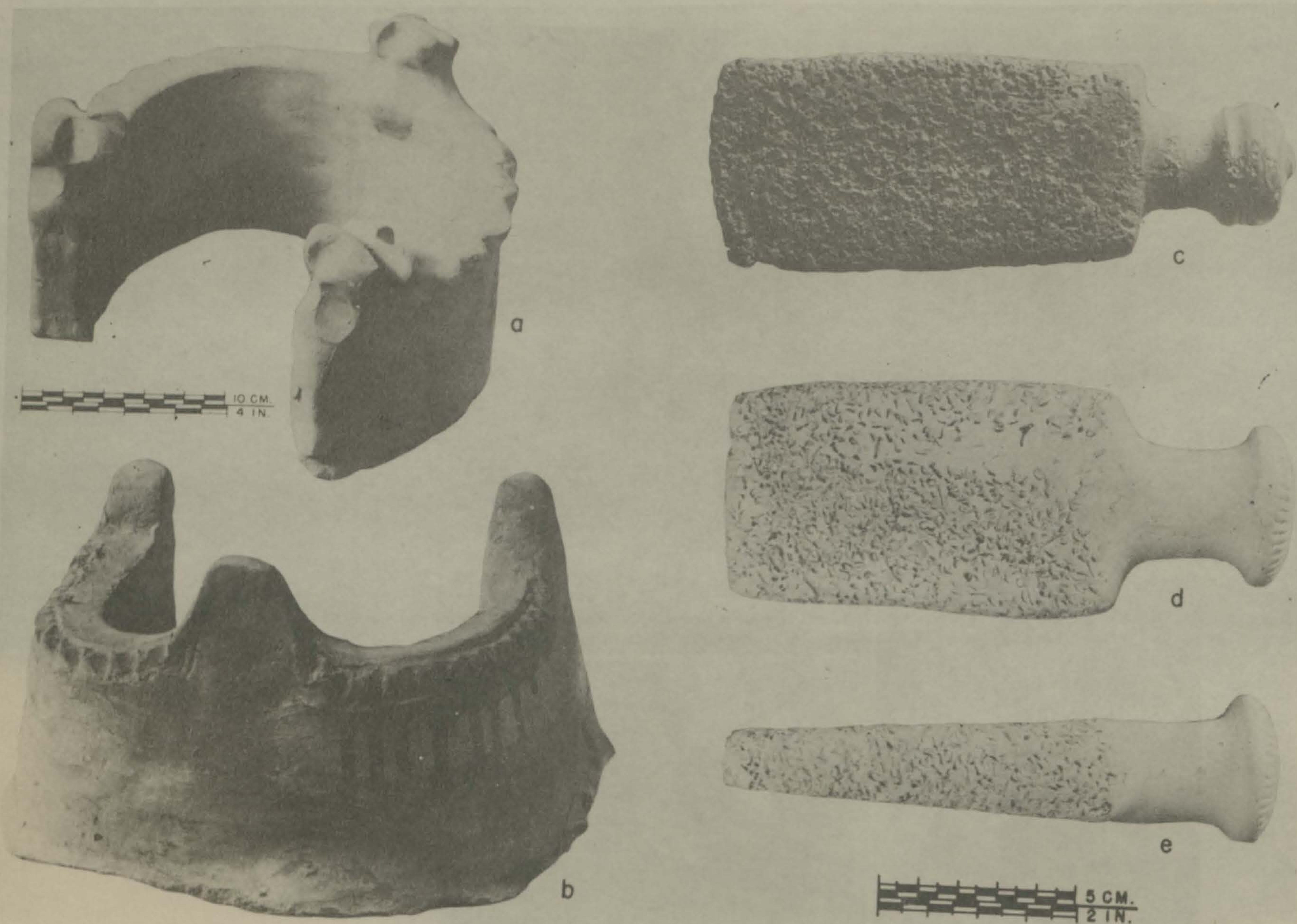


PLATE 49.—Miscellaneous unglazed ware from various localities: *a*, cooking pot stand with modeled decoration, Swat (USNM 417,374); *b*, cooking pot stand with modeled decoration, red slip, Bahawalpur (USNM 417,180) (note the three points on which the cooking pot rests); *c*, foot scraper, Bahawalpur (USNM 417,182), also used for removing mud from shoes; *d*, foot scraper, Quetta (USNM 414,551); *e*, profile view of *d*.



PLATE 50.—Preparing clay for use, Quetta, Baluchistan: *a*, pouring water into hollowed pile of sieved clay; *b*, removing plastic clay from the pile; *c*, rolling clay into a ball; *d*, sequence of stages in hand-kneading a lump of clay.

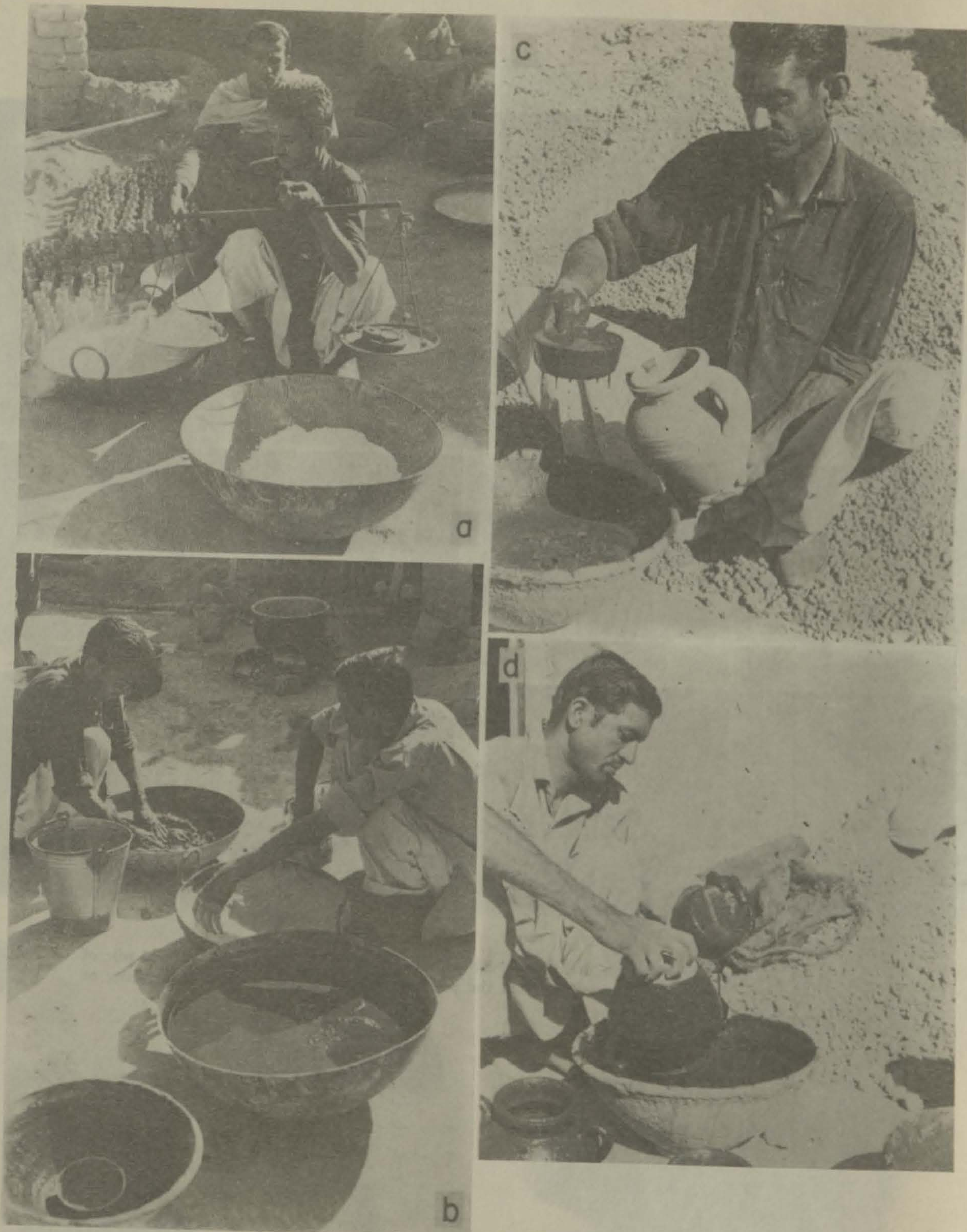


PLATE 51.—Preparing and applying glaze, Quetta, Baluchistan: *a*, weighing glaze materials; *b*, mixing glaze in an iron dish; *c*, pouring glaze into interior of urn (excess glaze is poured from the vessel back into the large bowl of glaze); *d*, pouring glaze over the exterior of a vessel.

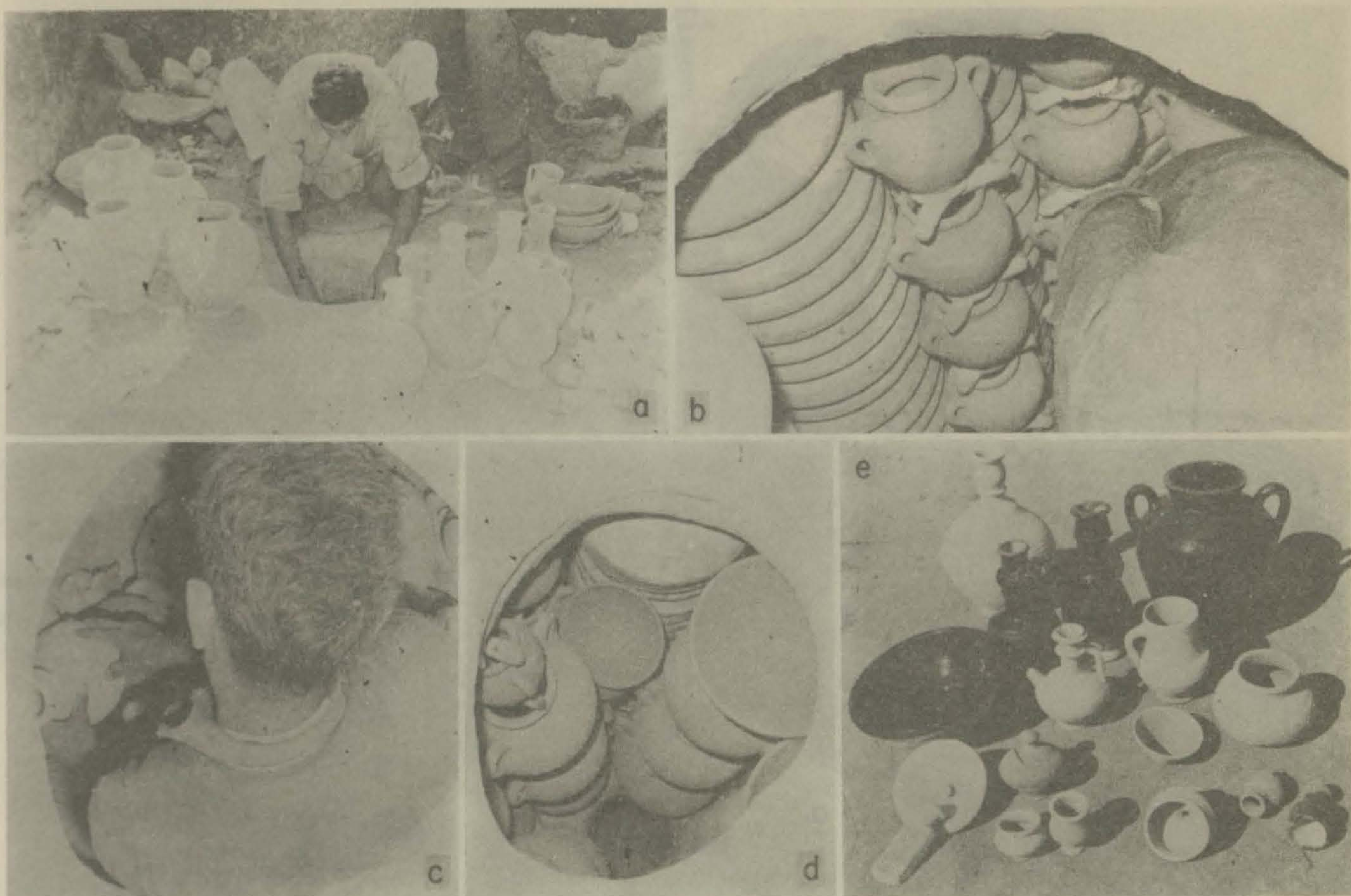


PLATE 52.—Setting kiln for glazed ware firing, Quetta, Baluchistan: *a*, an assistant passing vessels down to the setter inside the kiln; *b*, glazed ware set on stilts, viewed through top hole in kiln; *c*, setter working in restricted central area of chamber; *d*, completed setting (final vessels placed after the setter has climbed out of the kiln); *e*, a range of vessels produced in one Quetta potter's workshop.

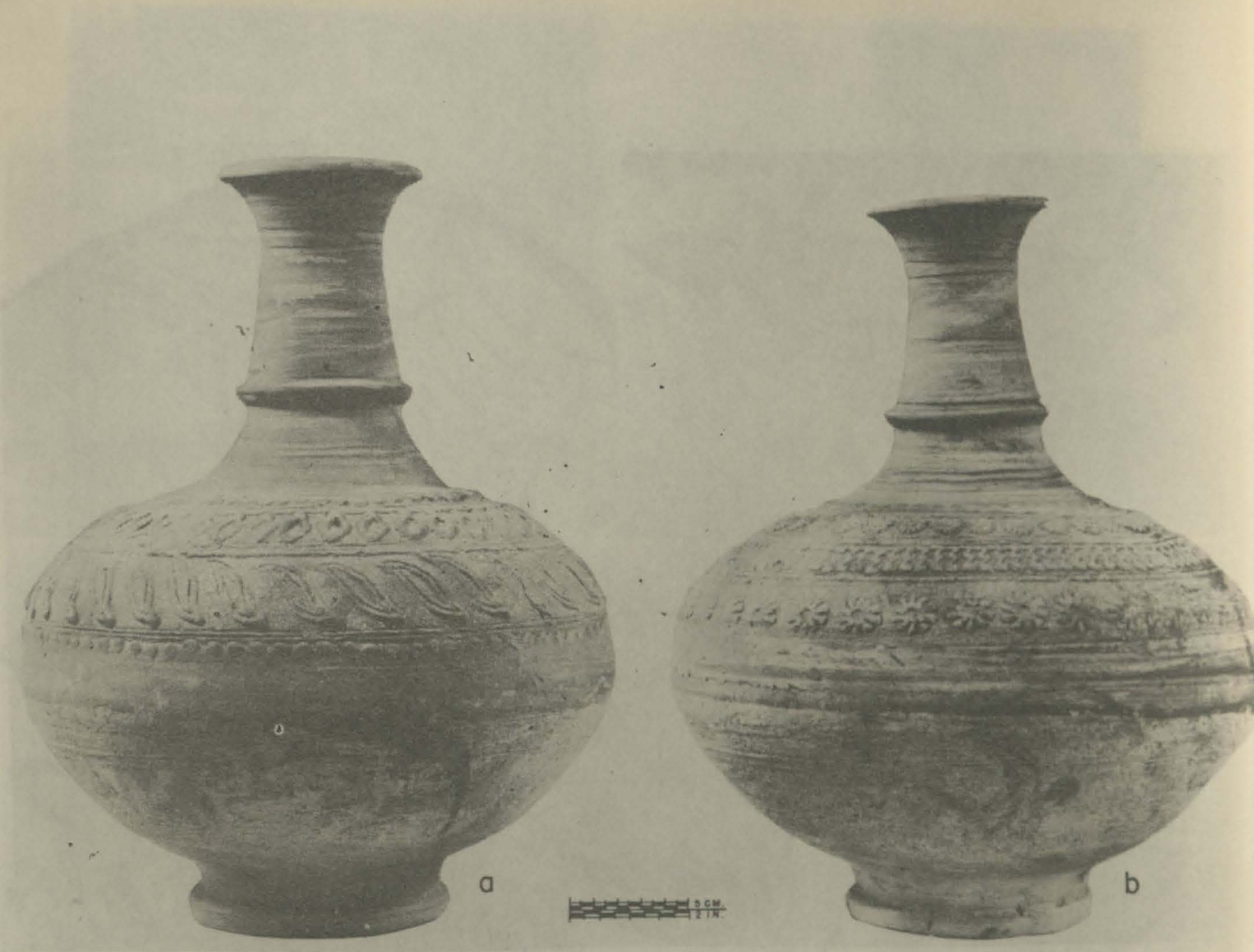


PLATE 53.—Unglazed water jars (*surāhī*), Quetta, Baluchistan, mold-formed (note mold seam and join marks around vessels at widest point) in two part mold, neck and foot thrown after molding, relief (molded) decoration, red slip applied to upper areas, used for storing drinking water: *a*, USNM 414,546-A; *b*, USNM 414,546-B.



PLATE 54.—Glazed ware vessels, Quetta, Baluchistan: *a*, water pipe or hookah base (*cilam*), dark brown glaze over brown slip (vessel has been fired upside down, evidenced by glaze drip on rim of pipe-stem socket, top left of vessel), incised and impressed decoration (USNM 414,547); *b*, large urn, green glaze over brown slip, impressed decoration around rim (used for storing pickles, oil and *ghī*) (USNM 414,542); *c*, small urn, brown glaze over brown slip, impressed decoration around rim (USNM 414,544).

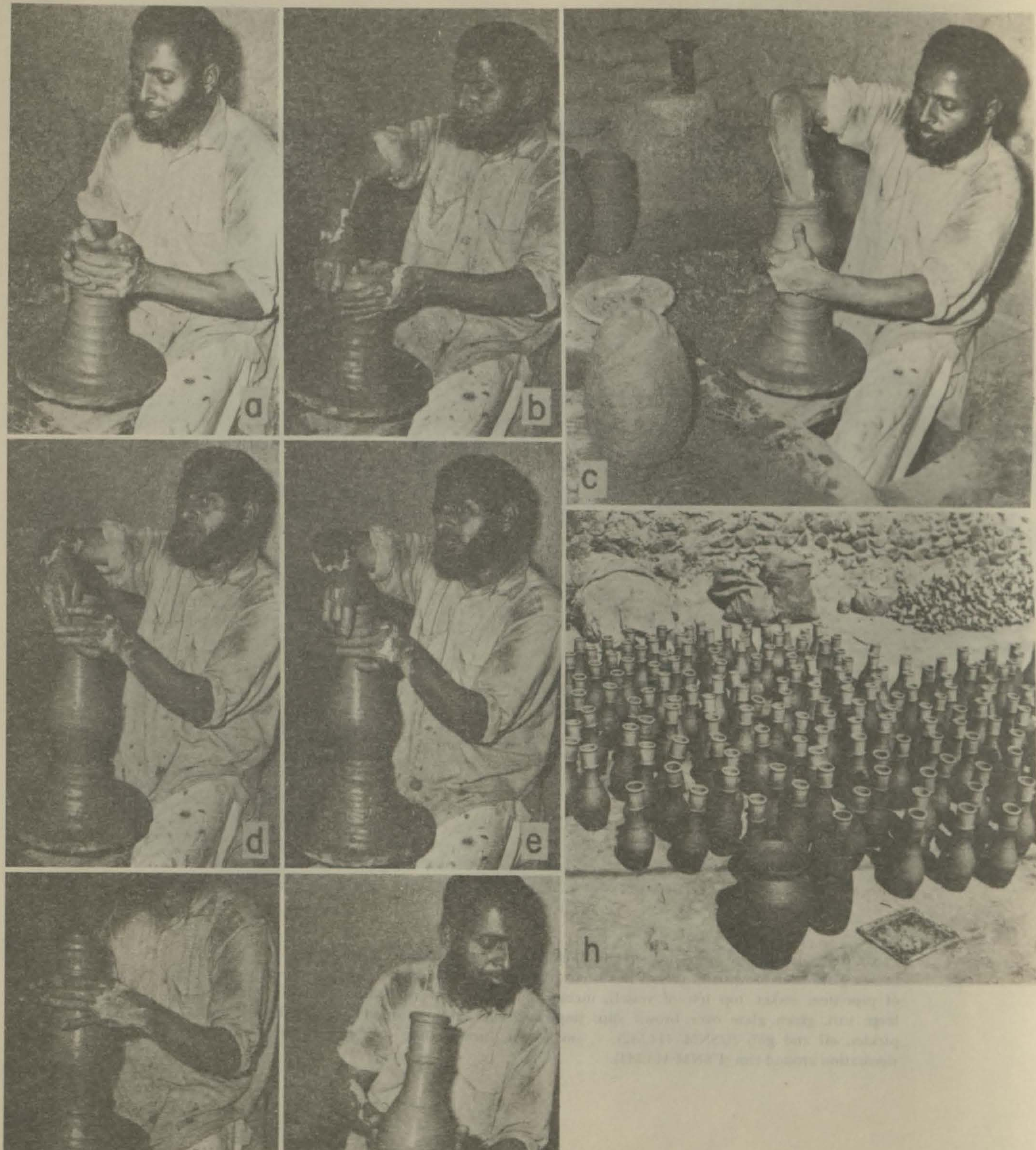


PLATE 55.—Potter Roshan Din throwing hookah (*cilam*) on the pit-wheel, Zakhel Bala, NWPF: *a*, *b*, opening the lump of clay; *c*, *d*, lifting clay; *e*, forming the rim; *f*, collaring the neck; *g*, removing completed vessel from the wheelhead (note lump of clay still on wheelhead; this is used to make the next vessel "throwing from the hump"); *h*, thrown vessels drying in the courtyard.

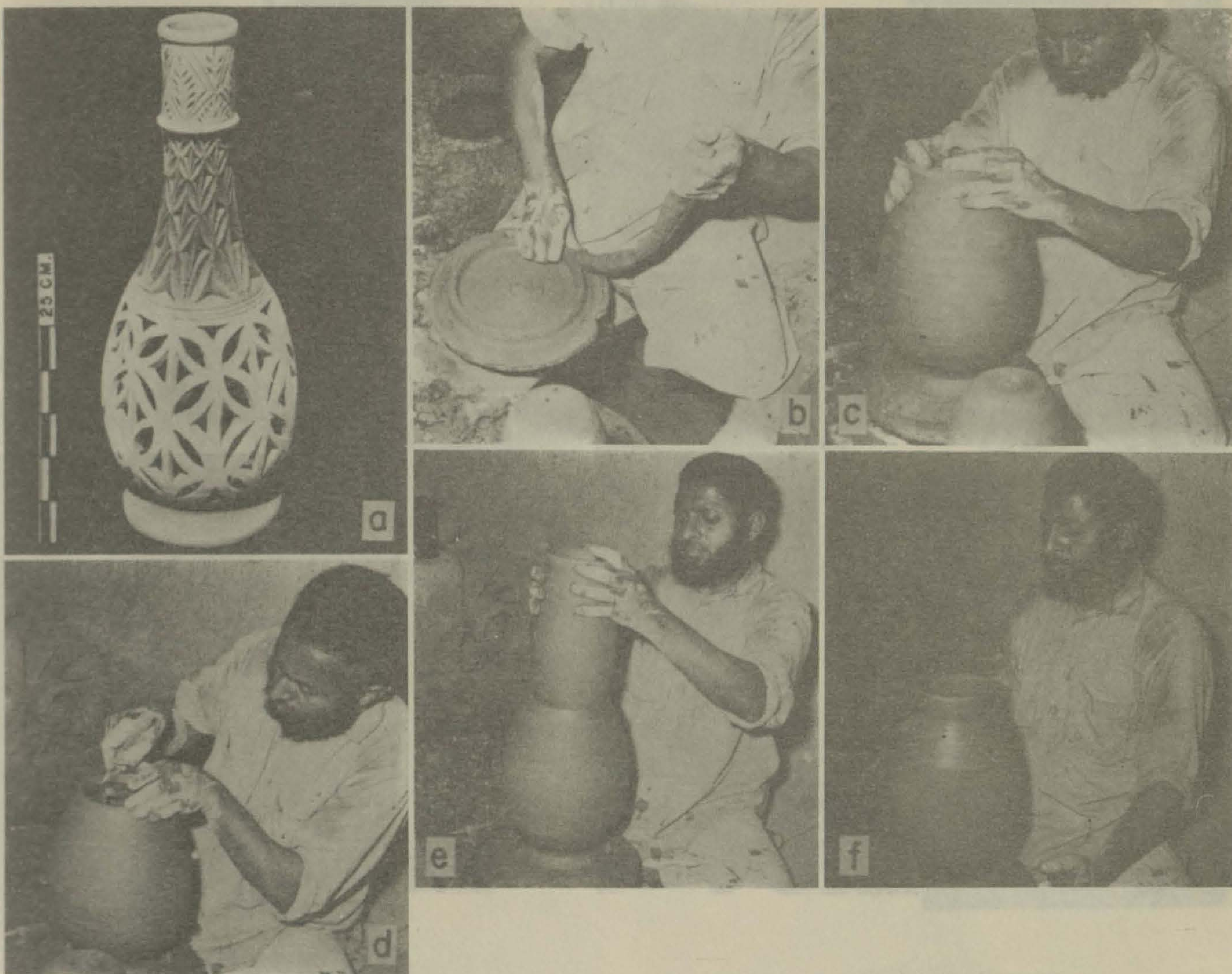


PLATE 56.—Potter Roshan Din forming a large hookah (*cilam*) with double walls, Zakhel Bala, NWFP: *a*, completed form of the *cilam*, *b*, fixing a clay chuck to the wheelhead; *c*, placing thrown form of outer wall of vessel in chuck; *d*, turning the outer form and cutting out the base; *e*, placing inner form inside the outer; *f*, inner and outer form joined. (See Plate 57.)

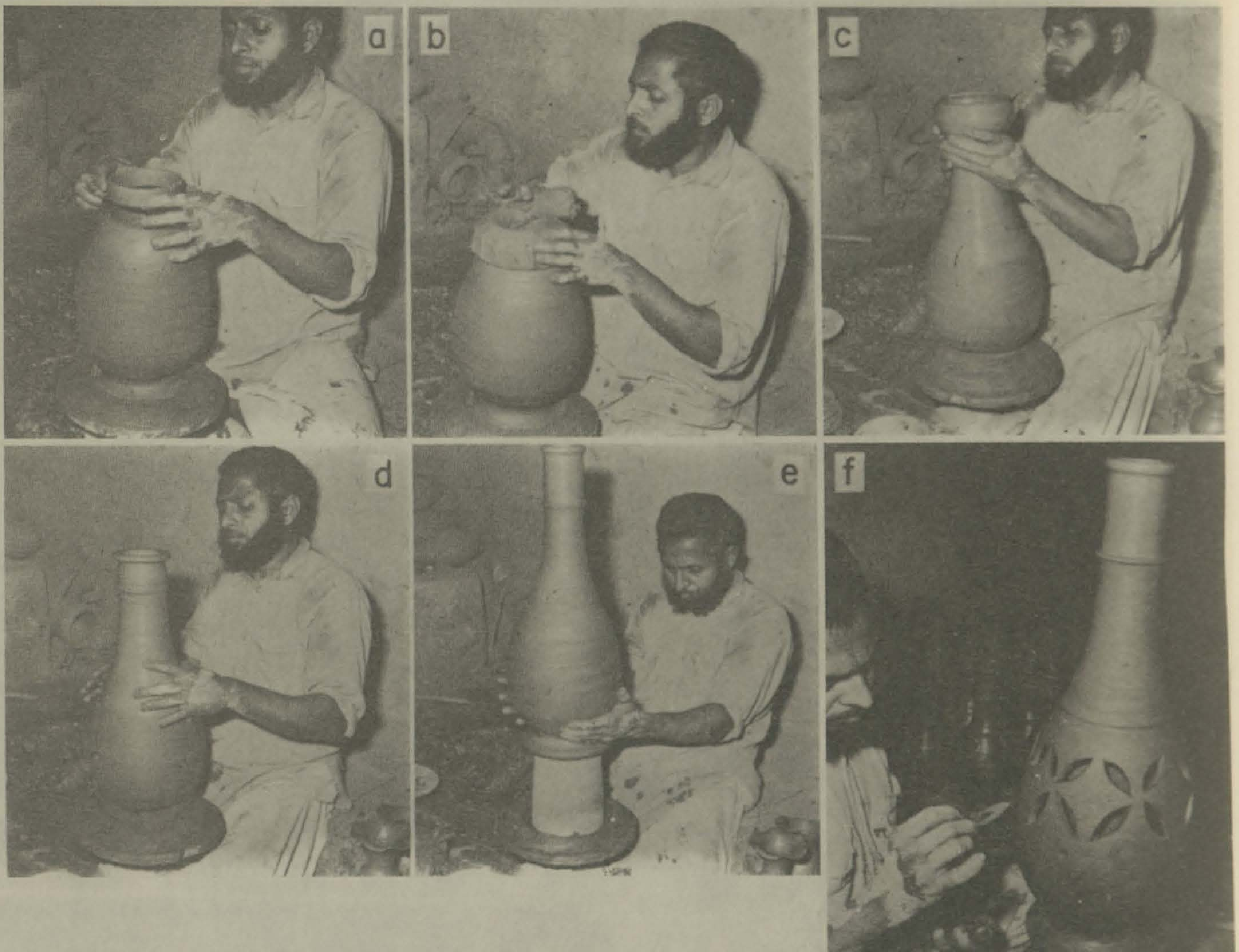


PLATE 57.—Potter Roshan Din forming a large hookah (*cilam*) with double walls, Zakhel Bala, NWFP (continued): *a*, removing excess clay from top of inner form; *b*, joining a coil of clay to top of combined forms; *c*, *d*, throwing coil of clay to form neck of *cilam*; *e*, placing the completed form on a prop on the wheelhead, to raise it to eye level; *f*, carving stylized decoration as perforations in the outer wall of the *cilam* (water will be contained by the inner form when the vessel is in use).

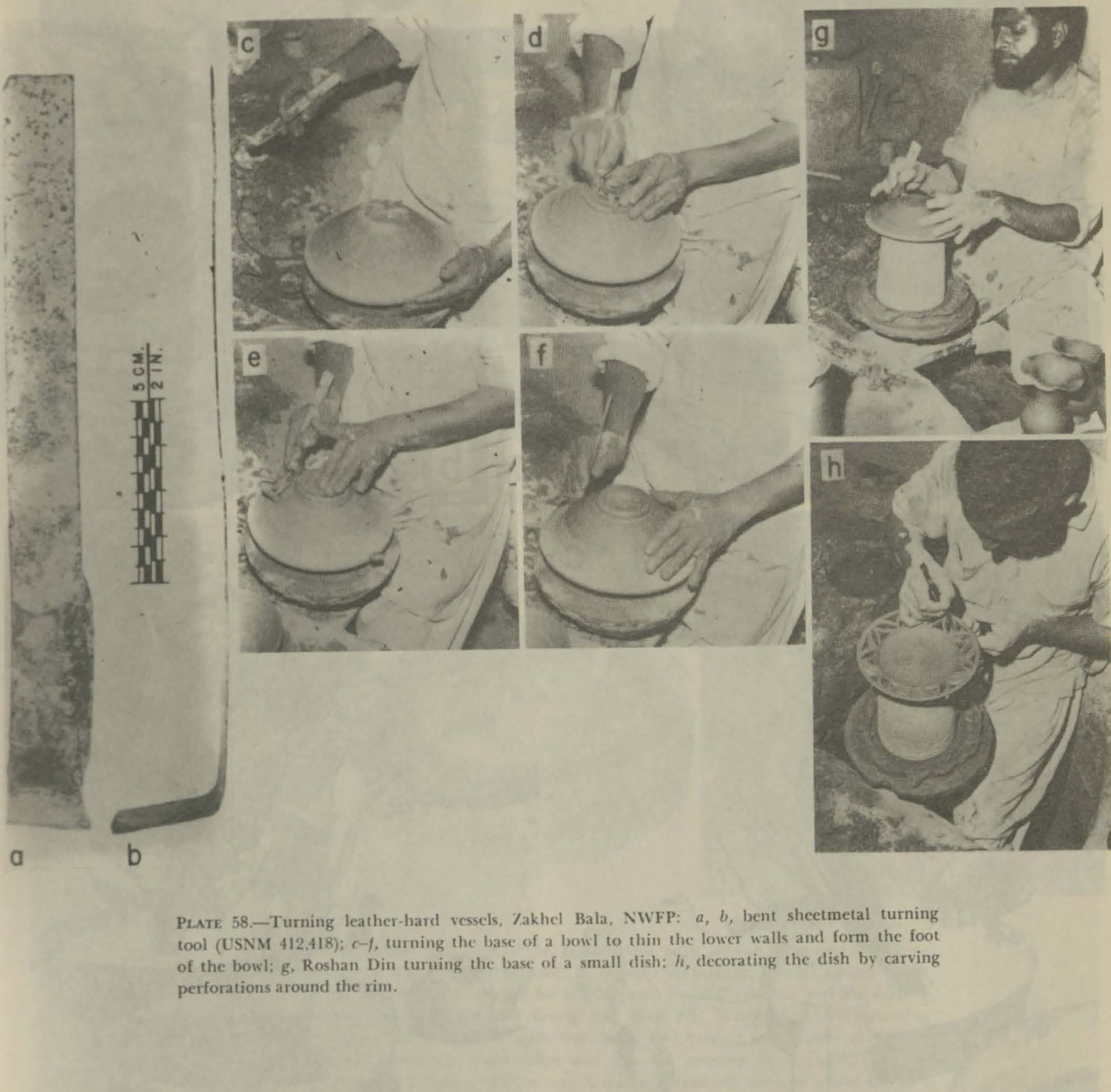


PLATE 58.—Turning leather-hard vessels, Zakhel Bala, NWFP: *a*, *b*, bent sheetmetal turning tool (USNM 412,418); *c–f*, turning the base of a bowl to thin the lower walls and form the foot of the bowl; *g*, Roshan Din turning the base of a small dish; *h*, decorating the dish by carving perforations around the rim.



PLATE 59.—Potter Hassan Din applying slip and pigment decoration, Zakhel Bala, NWFP: *a*, wiping red slip, with a cloth, onto a molded water jar, which is revolving on the pit wheel; *b*, painting black pigment decoration (bands) with a donkey-hair brush; *c*, pouring white slip over a *cilam*, which will later be glazed; *d*, allowing excess slip to drain from the vessel.



PLATE 60.—Glazemaking, Zakhel Bala, NWFP: *a*, Hassan Din, with his son, demonstrating how molten lead is stirred in a lead roasting furnace; *b*, closeup of furnace, overall height about 0.5 m, stokehole for fuel at front, top opening for placing lead in fixed crucible and for stirring and removing lead oxide; *c*, frit furnace for fusing lead glaze frit, Hassan Din demonstrating how molten frit is scooped out of crucible with iron ladle and poured into water; *d*, closeup of frit furnace, stokehole lower left, observation and removal opening front right, charging hole at top (sealed when the furnace is in use); *e*, *f*, quern (handmill) used to grind frit and other glaze materials, grinding stone (raised in *e*) 0.5 cm diameter; *g*, crucible removed from frit furnace, with some frit still in it (diameter 35 cm, made from normal pottery body).

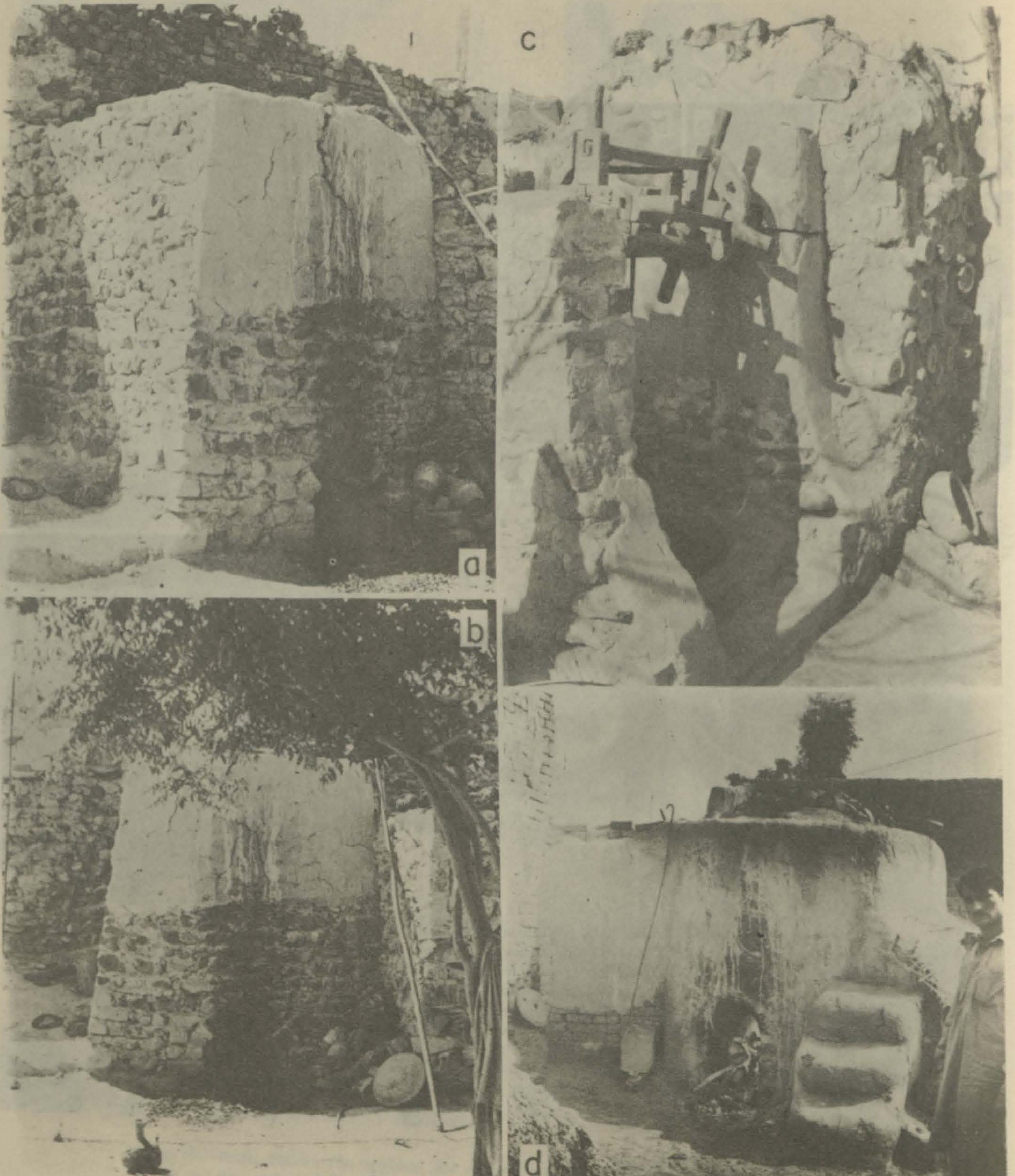


PLATE 61.—Kilns, Zakhel Bala, NWFP: *a, b,* updraught kiln used by Roshan Din and Hassan Din (see Figure 21); *c,* well in the potter's courtyard, Zakhal Bala, *d,* updraught kiln at Pabbi, near Zakhel Bala, during firing; sherds cover top opening of kiln (in dark area, top).



PLATE 62.—Potter Roshan Din demonstrating kiln construction, Zakhel Bala, NWFP: *a*, stick in foreground used to measure dimensions of kiln plan (broken lines); *b*, setting out position of stokehole; *c*, method of cutting bricks with an adze-like tool; *d*, first two courses of the firebox and stockhole completed; *e*, stockhole, closed by corbelling, completed (first courses of outer insulating wall laid); *f*, commencing construction of firebox. (See Plate 63.)

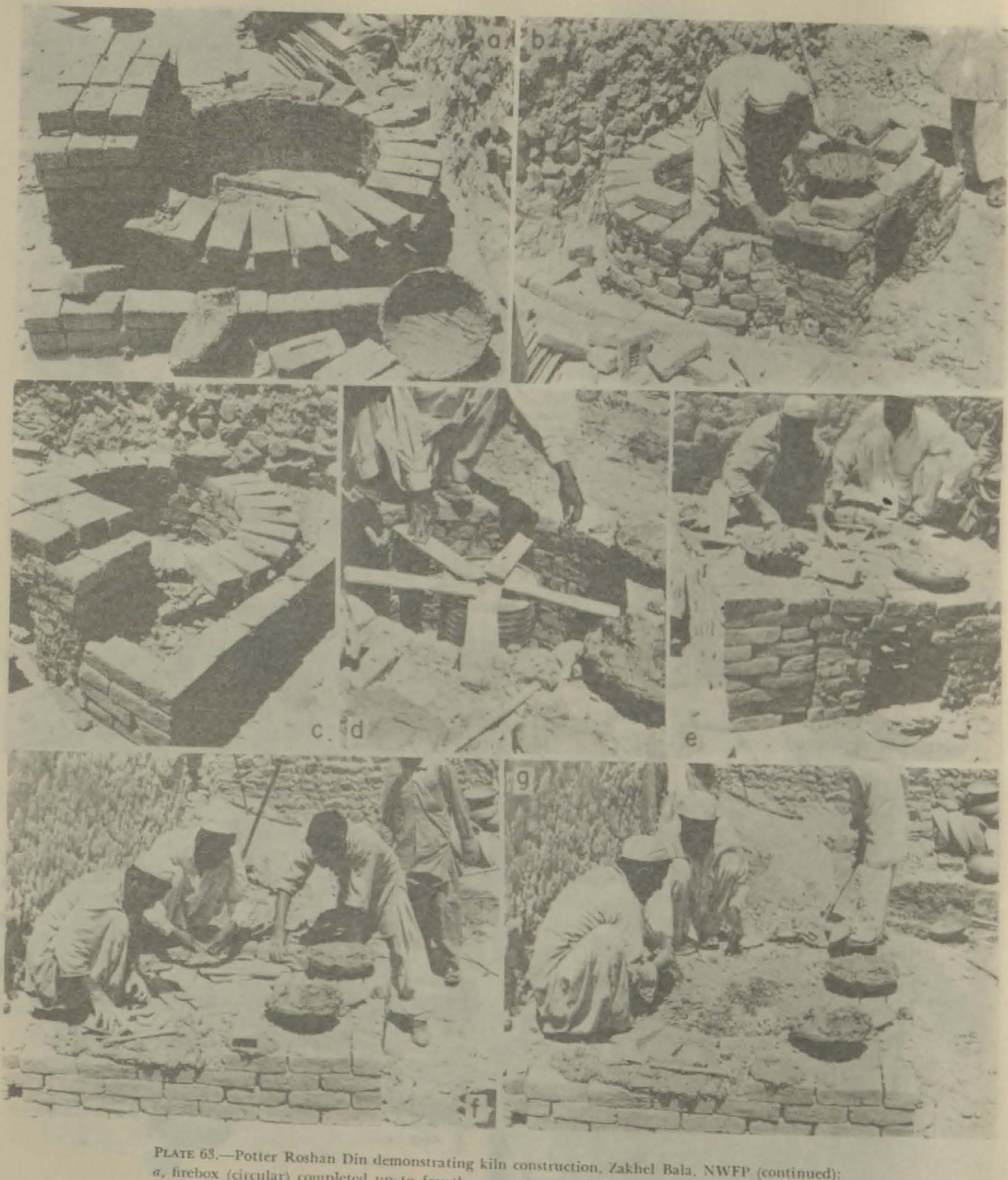


PLATE 63.—Potter Roshan Din demonstrating kiln construction, Zakhel Bala, NWFP (continued): *a*, firebox (circular) completed up to fourth course (note radial course); *b*, continuing construction of firebox; *c*, outer insulating wall completed to fourth course (gap between firebox and outer wall filled with dry clay); *d*, building a chamber floor, a steel drum used to support wooden formwork; *e*, *f*, wooden formwork to support floor is placed in position; *g*, formwork covered with dry clay, level with brickwork at edges and raised in center. (See Plate 64).



PLATE 64.—Potter Roshan Din demonstrating kiln construction, Zakhel Bala, NWFP (continued): *a*, wood/clay formwork completed, a further radial course of bricks laid; *b*, ready to build the domed floor, rise of the clay formwork for floor may be compared with stick placed across top; *c*, using bricks to measure off equidistant spaces, and determine position of flamethroats (broken lines); bricks are removed after location of flamethroats has been determined; *d*, *e*, commencing floor construction (bricks laid in circular pitched (on edge) courses). (See Plate 65.)



PLATE 65.—Potter Roshan Din demonstrating kiln construction, Zakhel Bala, NWFP (continued): *a*, chamber floor (dome over firebox) brickwork completed; *b*, flamethroats (openings) built up with plastic clay, then dry clay shoveled in to level floor; *c*, water has been sprinkled on dry clay; *d*, wet clay is trowelled over floor to smooth and level it; *e*, kiln completed to chamber floor level (the circular brickwork will be continued upward to form the chamber; the square outer wall will be continued upward to form the outer insulating wall; formwork (steel drums, wood, dry clay) is removed from under floor through the stokehole at front).

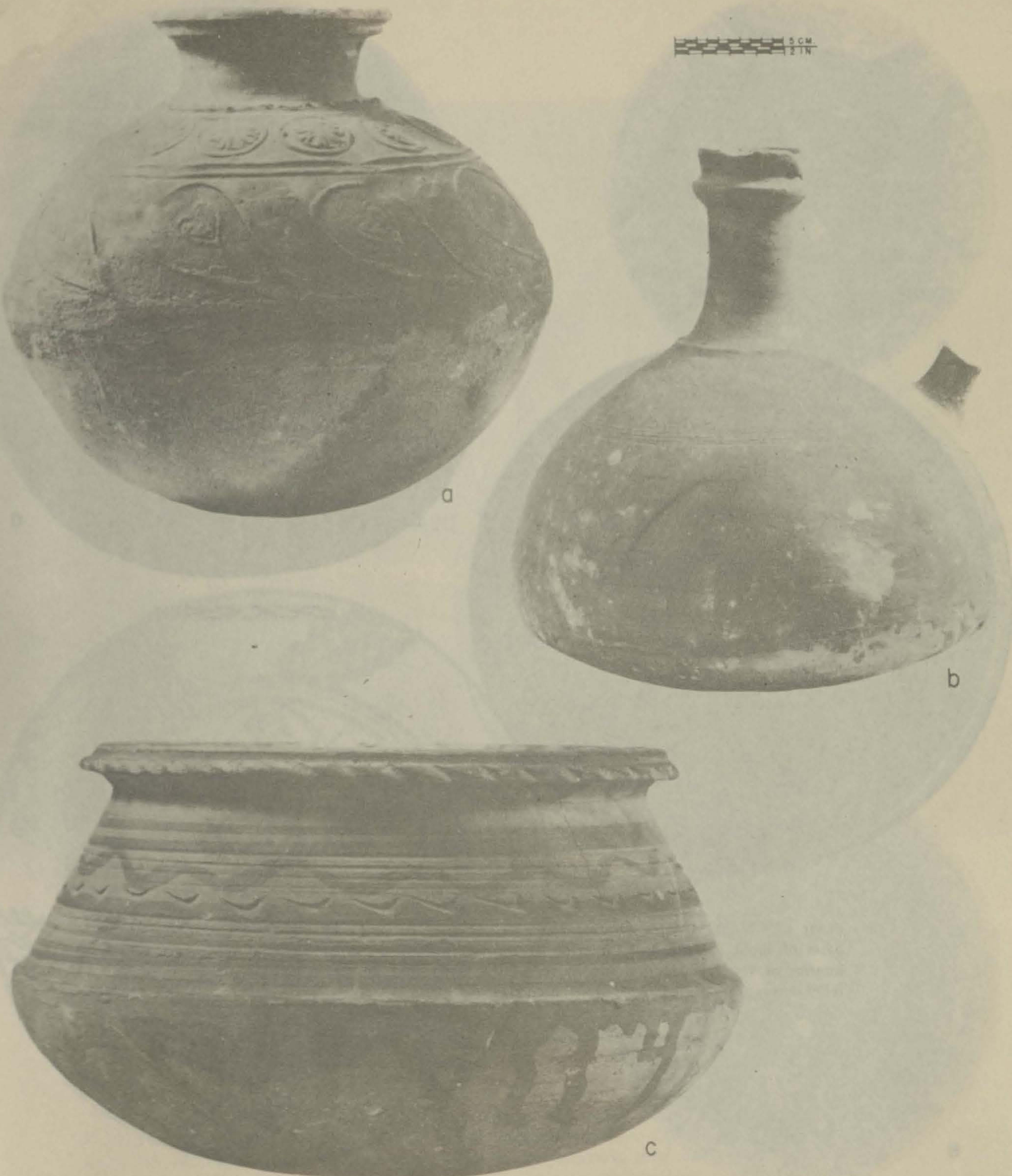


PLATE 66.—Unglazed earthenware, Zakhel Bala, NWFP: *a*, water jar (*mangay*) formed in two-piece mold (Plate 67), neck thrown, red slip on upper walls (USNM 412,410); *b*, water pitcher (*kūzā*) with spout, incised bands on shoulder, decorated with overall red slip, used for ritual ablutions (USNM 412,411); *c*, cooking pot (USNM 412,412-A) used with lid (USNM 412,412-B), base mold-formed (note seam around widest point), decorated with incised and impressed patterns, red slip, black pigment bands.



PLATE 67.—Mold used for forming water jars, Zakhel Bala, NWFP (USNM 412,416): *a*, two parts of mold assembled; *b*, interior of top mold showing central hole allowing access to interior of vessel for joining two halves of the vessel, and impressed decoration which forms relief decoration on the molded vessel, fired clay. (cf. Plates 21, 22.)



PLATE 68.—Glazed bowls with underglaze decoration, Zakhel Bala and Pabbi, NWFP: *a,* white slip decoration (brushed), clear lead glaze on red body, Pabbi (USNM 417,308-F); *b,* white slip, blue and brown pigment decoration, clear glaze on interior, Zakhel Bala (USNM 412,466); *c,* red body, white slip painting, green glaze, Pabbi (USNM 417,308-C); *d,* profile of *a; e,* white slip overall, green glaze on interior, Pabbi (note three stiltmarks in center of bowl; bowls are fired upside down resting on three-pointed stilts which fuse to glaze; when broken away the three characteristic scars result) (USNM 417,308-D). (Note that all bowls have no decoration or glaze on exterior.)

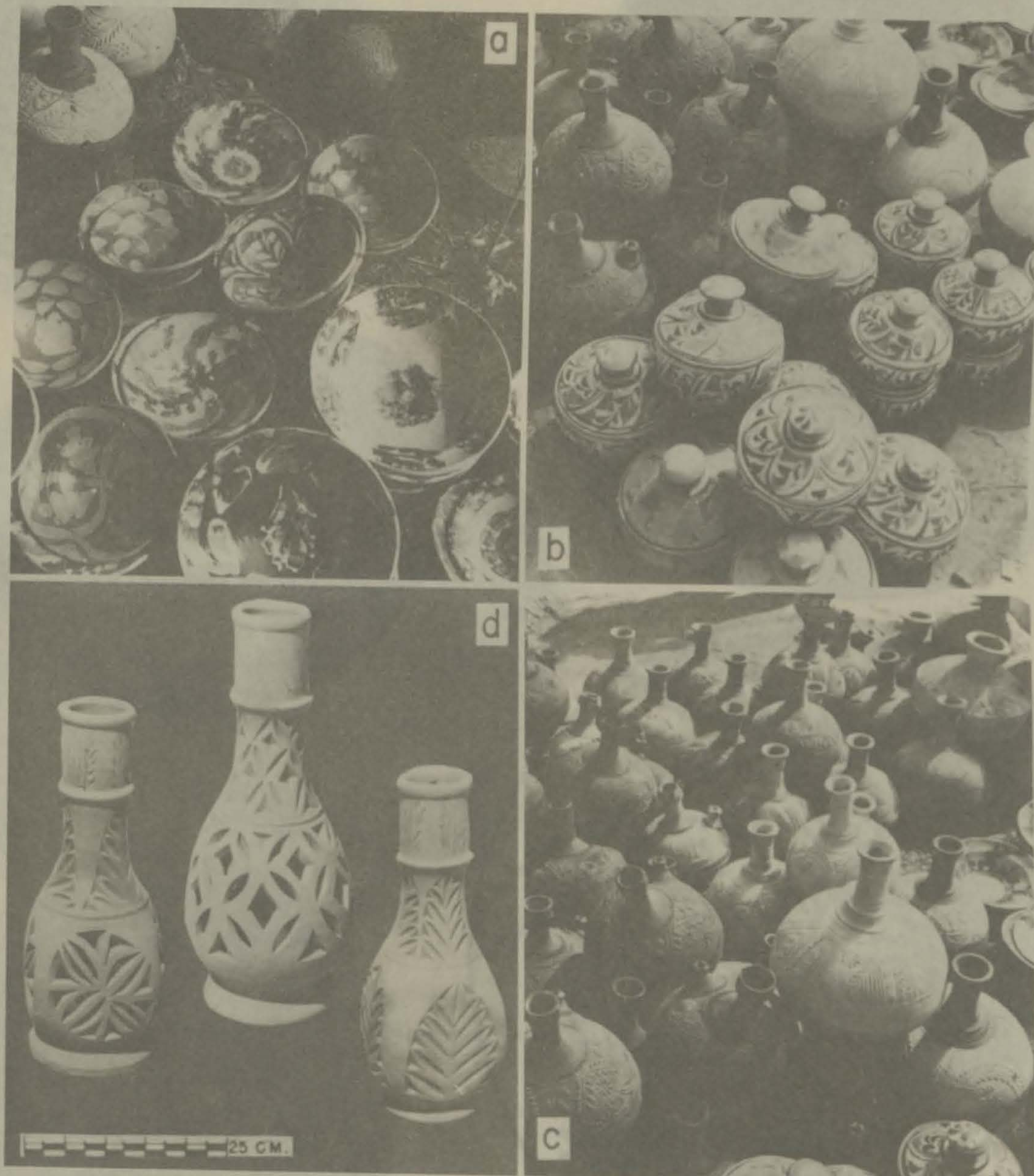


PLATE 69.—Glazed ware from Pabbi bazaar, NWFP: *a*, range of glazed bowls from Pabbi and Zakhel Bala; *b*, covered glazed dishes and unglazed water pitchers; *c*, three *cilam* (hookahs), decorated with incised (single-wall) or perforated (double-wall; see Plates 56,57) designs, from Zakhel Bala (these vessels were photographed day before glaze or slip had been applied); *d*, unglazed, mold-formed water pitchers.



PLATE 70.—Potter Sahib Yar forming glazed ware, Multan, Panjab: *a*, foot-kneading clay body; *b*, hand-kneading; *c*, fixing a tile to the wheelhead; the tile is pressed down onto soft plastic clay to attach it firmly; *d*, placing, centering, and opening a lump of clay on the tile; *e*, forming a dish; *f*, removing the dish and tile from the wheel together, by lifting off the tile, so that the dish will not be distorted by lifting it alone.



PLATE 71.—Forming a vase in sections, Multan, Panjab: *a*, throwing the main body of the vessel (here vessel is being cut off with a thread before removal from the wheelhead); *b*, forming pedestal foot for vase; *c*, *d*, forming neck and rim of vase; *e*, *f*, joining foot of vessel to main body and attaching main body to the wheelhead in a clay chuck; *g*, *h*, attaching neck and rim section by the same method.



PLATE 72.—Slip application by master potter Khuda Baksh, Multan, Panjab: *a*, sieving ground slip, *b*, mixing flour glue with slip powder; *c*, thinning the slip with water; *d*, applying slip to a vase by pouring with the hand; *e*, splashing first coating of slip on a dish; *f*, first coating being rubbed off and a second coating of slip to be applied.

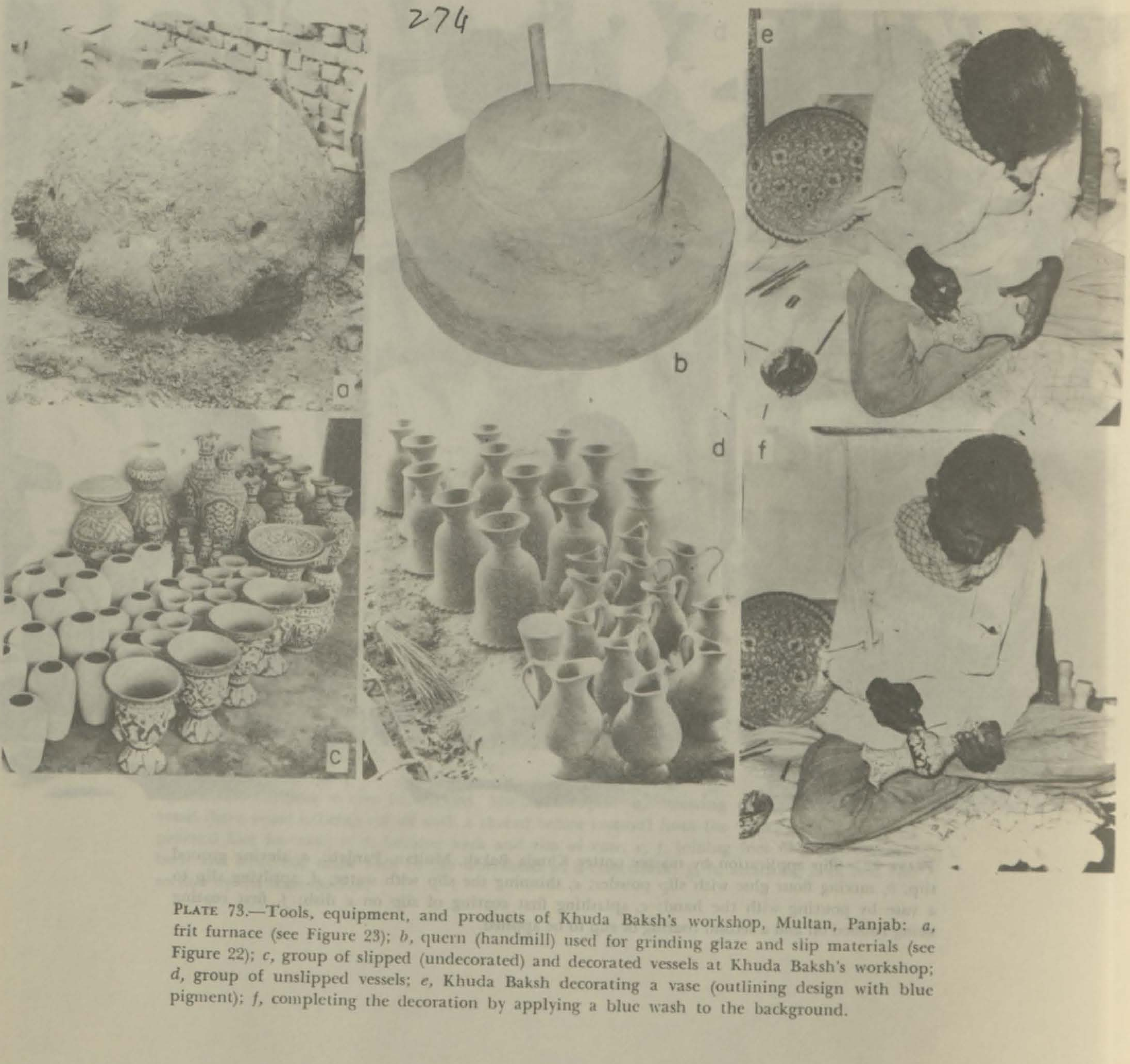


PLATE 73.—Tools, equipment, and products of Khuda Baksh's workshop, Multan, Panjab: *a*, frit furnace (see Figure 23); *b*, quern (handmill) used for grinding glaze and slip materials (see Figure 22); *c*, group of slipped (undecorated) and decorated vessels at Khuda Baksh's workshop; *d*, group of unslipped vessels; *e*, Khuda Baksh decorating a vase (outlining design with blue pigment); *f*, completing the decoration by applying a blue wash to the background.

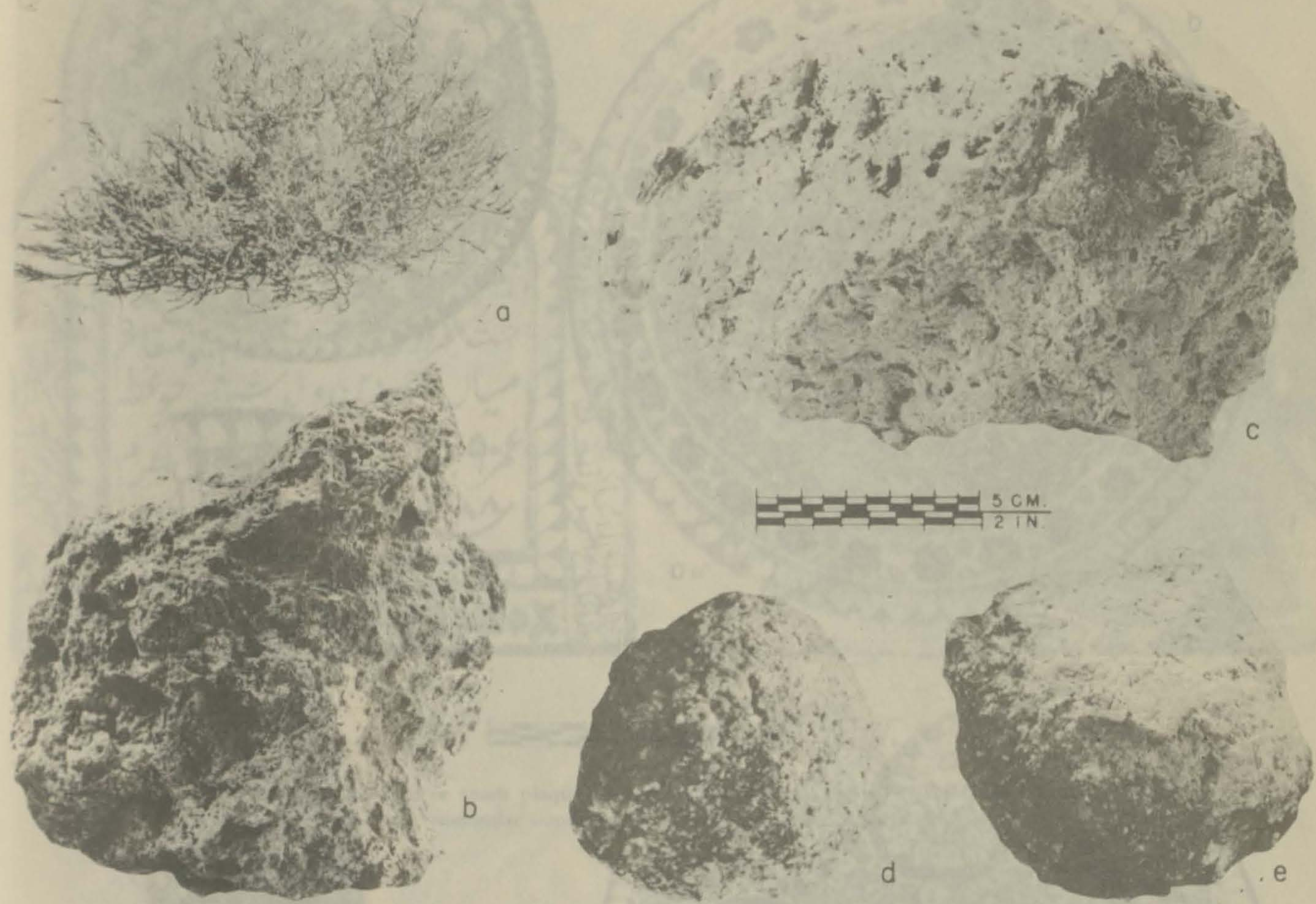


PLATE 74.—Plant ash materials from various localities: *a, khār* (*Haloxylon recurvum*) bush growing in the Cholistan Desert ca. 24 km east of Bahawalpur city (USNM 417,593); *b, khār*, produced by burning the *khār* bush in open pits, from Multan potter Khuda Baksh's workshop (USNM 417,590); *c, khār*, first grade (*cua khār*) from Cholistan Desert, from Bahawalpur producer (USNM 417,176); *d, e*, fused balls of mixed *khār* and quartzite (*karunḍ*) powder, fired in firebox of Multan master potter Khuda Baksh's kiln (USNM 417,199).

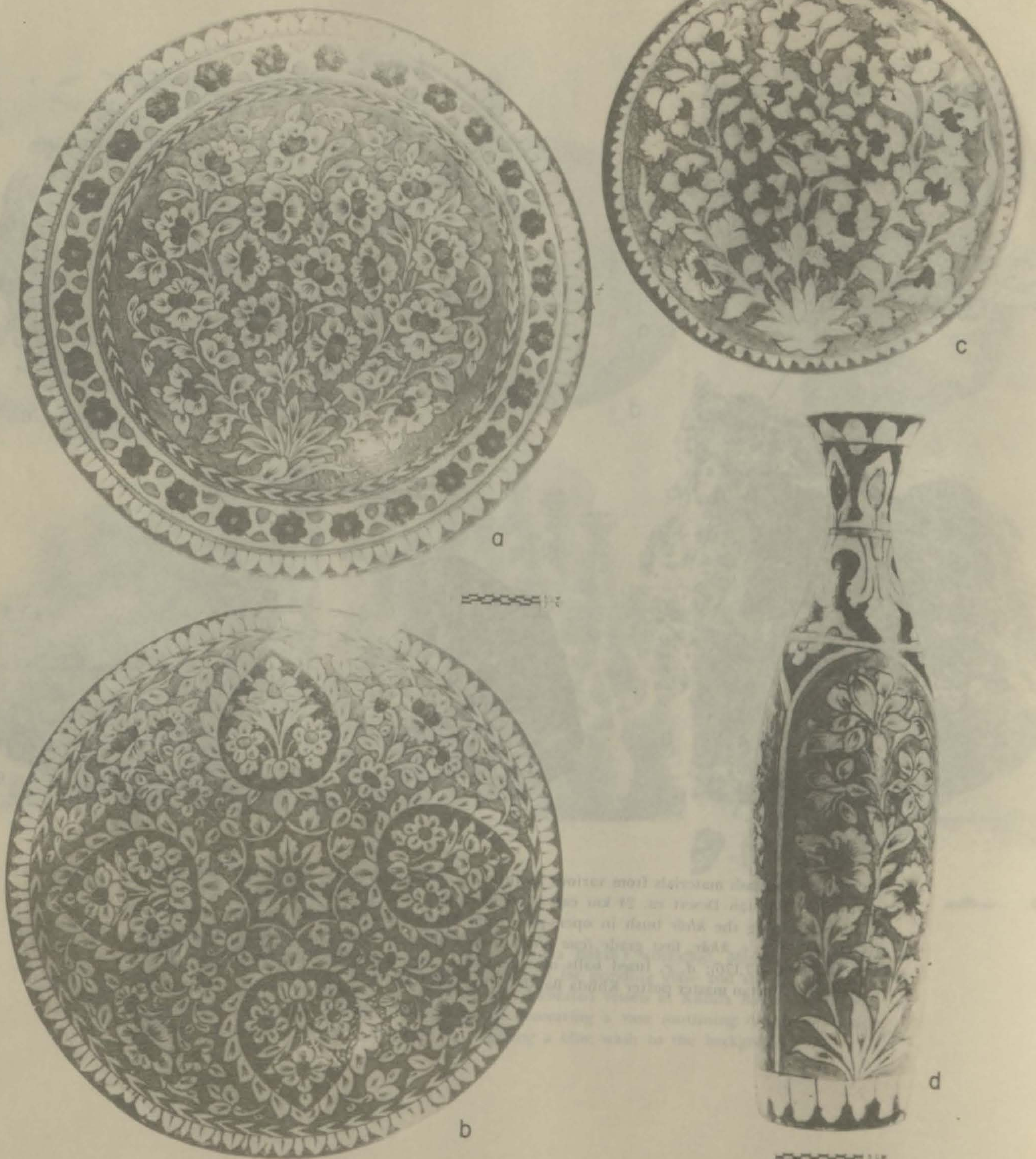


PLATE 75.—Multan blue ware, Multan, Panjab: *a*, large dish with *gul-dāirā* (flower circle) blue, turquoise, and white decoration, undecorated on back (USNM 417,190); *b*, large dish with *cār-takme-vālā* (four-section) blue, turquoise, and white decoration (USNM 417,192); *c*, dish with blue, turquoise, and white flower circle decoration (USNM 417,193-B); *d*, bottle-vase, blue, turquoise, and white (USNM 410,672) (note that this vase is reproduced at a different scale to the three dishes).

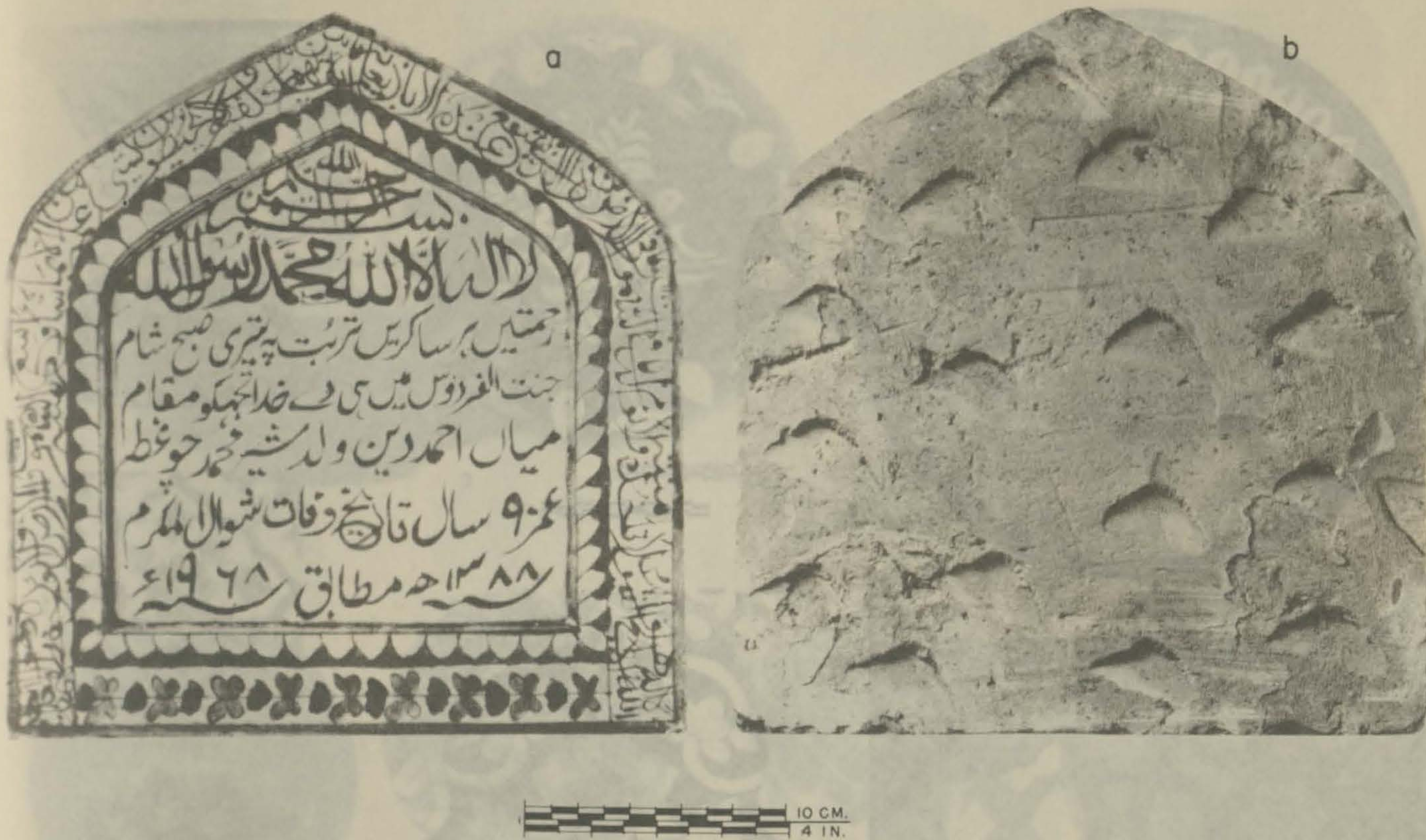


PLATE 76.—Gravestone or tomb plaque (*lauh-i mazār*), Multan, Panjab (USNM 417,194-A): *a*, front; *b*, obverse (note triangular impressions on back to improve adhesion of tile to plaster or mortar).

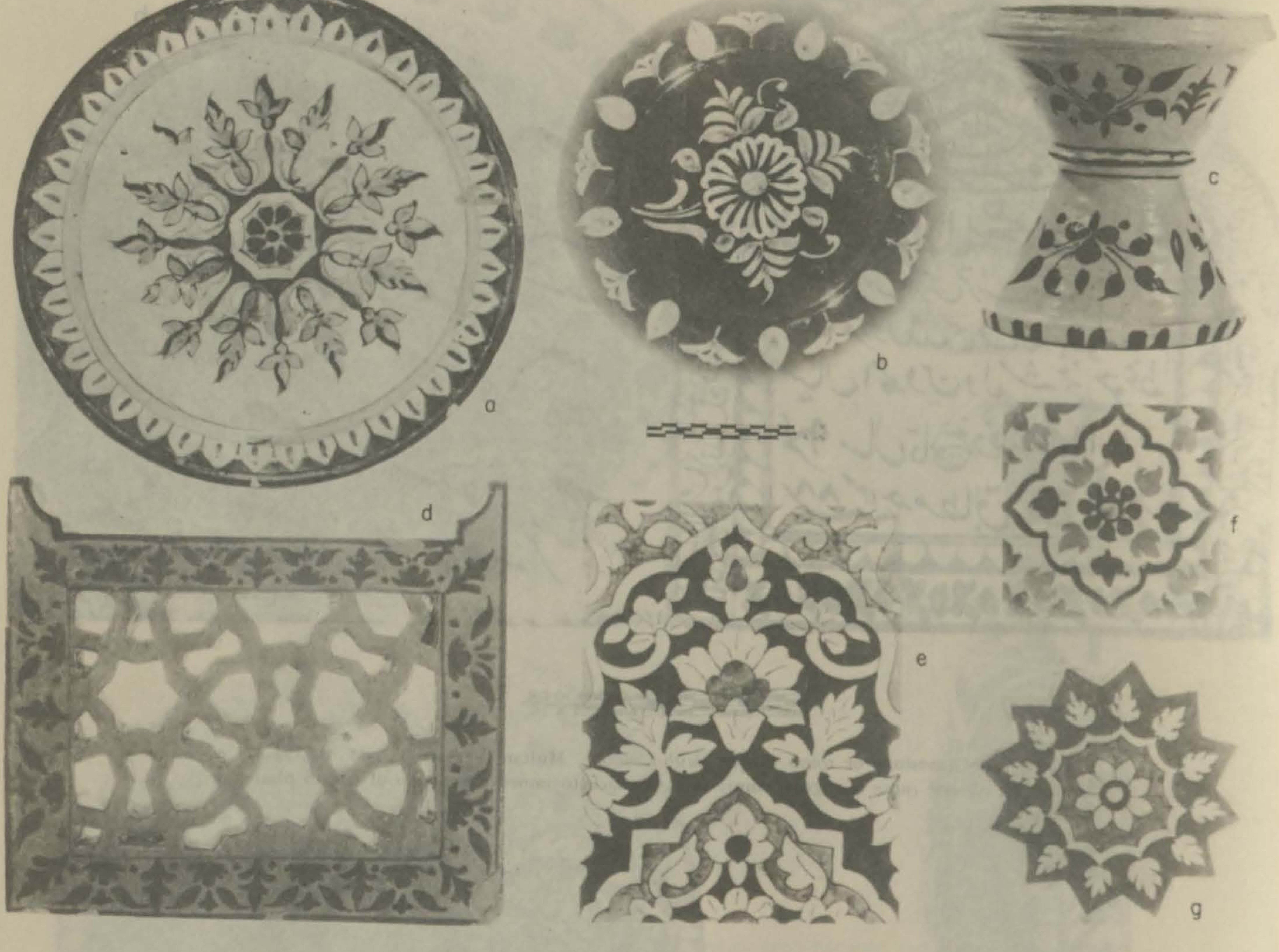


PLATE 77.—Glazed ware from Hala, Sind: *a*, large dish, pale red-pink body, white slip on upper surface, decorated with blue, turquoise, and green brushwork, clear alkaline glaze (USNM 417,120); *b*, plate decorated with brown slip brushwork, amber lead glaze (USNM 417,119-B); *c*, flower pot, white slip, blue pigment and pink slip brushwork, clear alkaline glaze (USNM 417,115); *d*, perforated tile, blue brushwork over white slip, turquoise alkaline glaze (USNM 410,492); *e*, tile, white slip on pinkish body, blue, turquoise, and green brushwork, clear alkaline glaze (USNM 410,491); *f*, tile with white slip, pink and brown slip brushwork, clear glaze (USNM 417,121-B); *g*, tile, 12-pointed, white slip, blue, green, and turquoise brushwork clear alkaline glaze (USNM 417,122).



PLATE 78.—Glazed ware from Hala, Sind: *a*, dish with lid (USNM 417,117-A,B) brown slip, white, pink, and green slip brushwork, clear lead glaze; *b*, top view of dish in *a*; *c*, top view of lid in *a*; *d*, dish with lid (USNM 417,113-A,B), white slip overall, pink and brown slip brushwork, amber lead glaze; *e*, top view of lid in *d*; *f*, top view of dish in *d*. (Note that *a* and *d* are reproduced at the indicated scale; *b*, *c*, *e*, and *f*, at half that scale.)

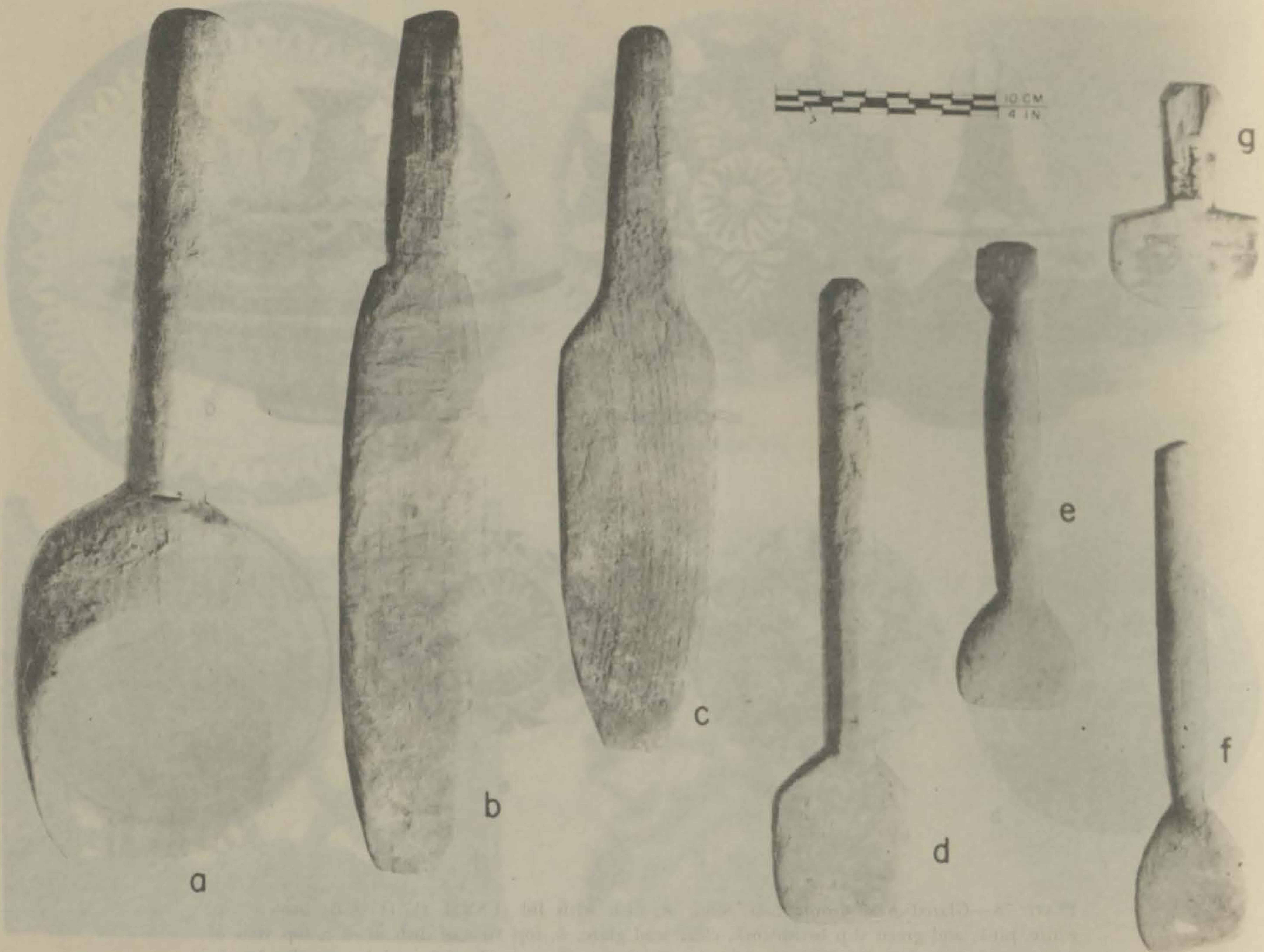


PLATE 79.—Paddles: *a*, Dir, NWFP (USNM 417,380); *b*, *c*, Seen, Chitral, NWFP (USNM 417,419-A,B). Smoothing tools (used for refining shape of thrown vessels on the potter's wheel): *d*, Dir, NWFP (USNM 417,384); *e*, Dir, NWFP (417,382); *f*, Dir, NWFP (USNM 417,383); *g*, Zakhel Bala, NWFP (USNM 412,419).

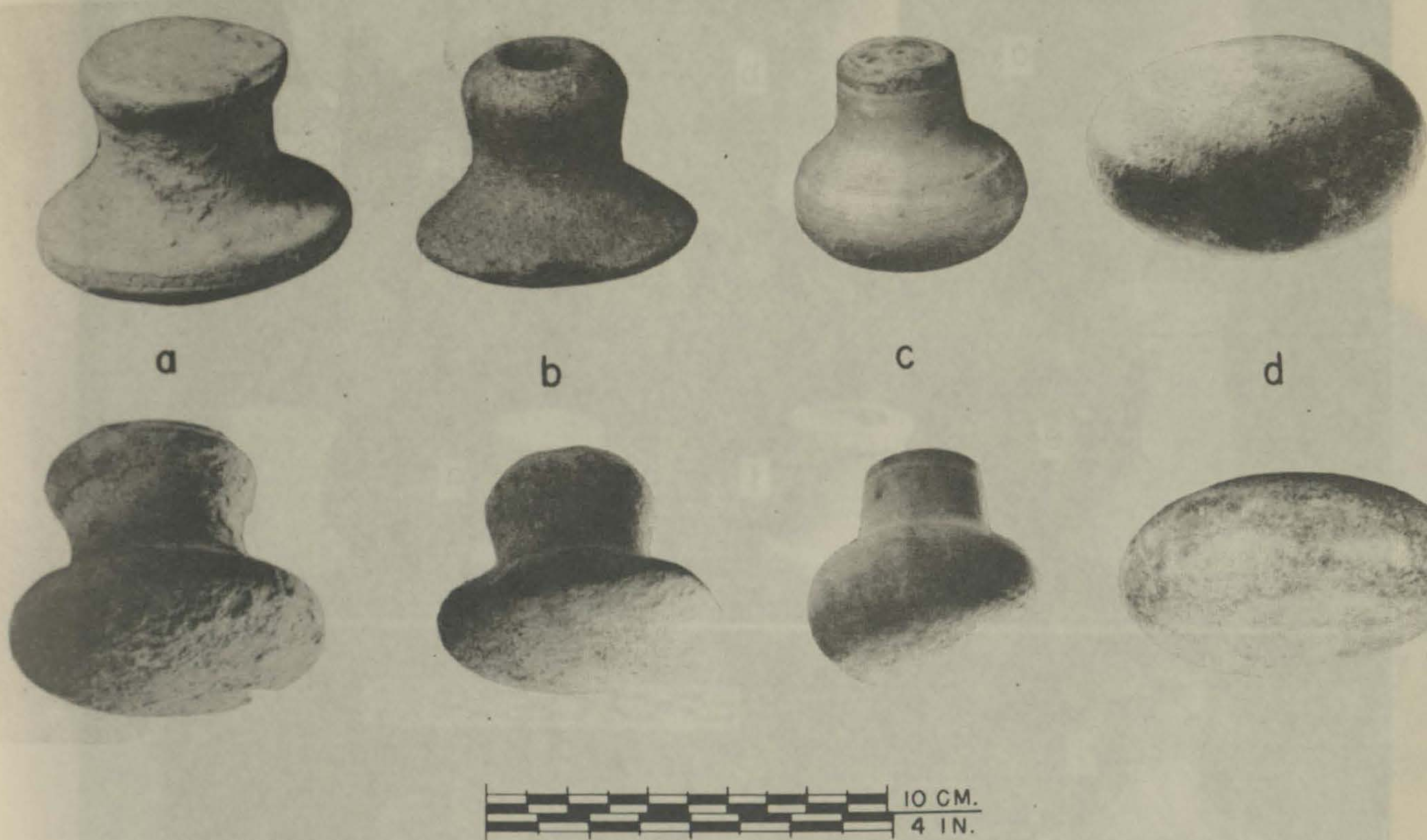


Plate 80.—Potter's anvils from various localities: *a* Zakhel Bala, NWFP (USNM 412,417); *b*, Dir, NWFP (USNM 417,381); *c*, Ahmedpur East, Panjab (USNM 410,652-E); *d*, Seen, Chitral, NWFP (USNM 417,420).

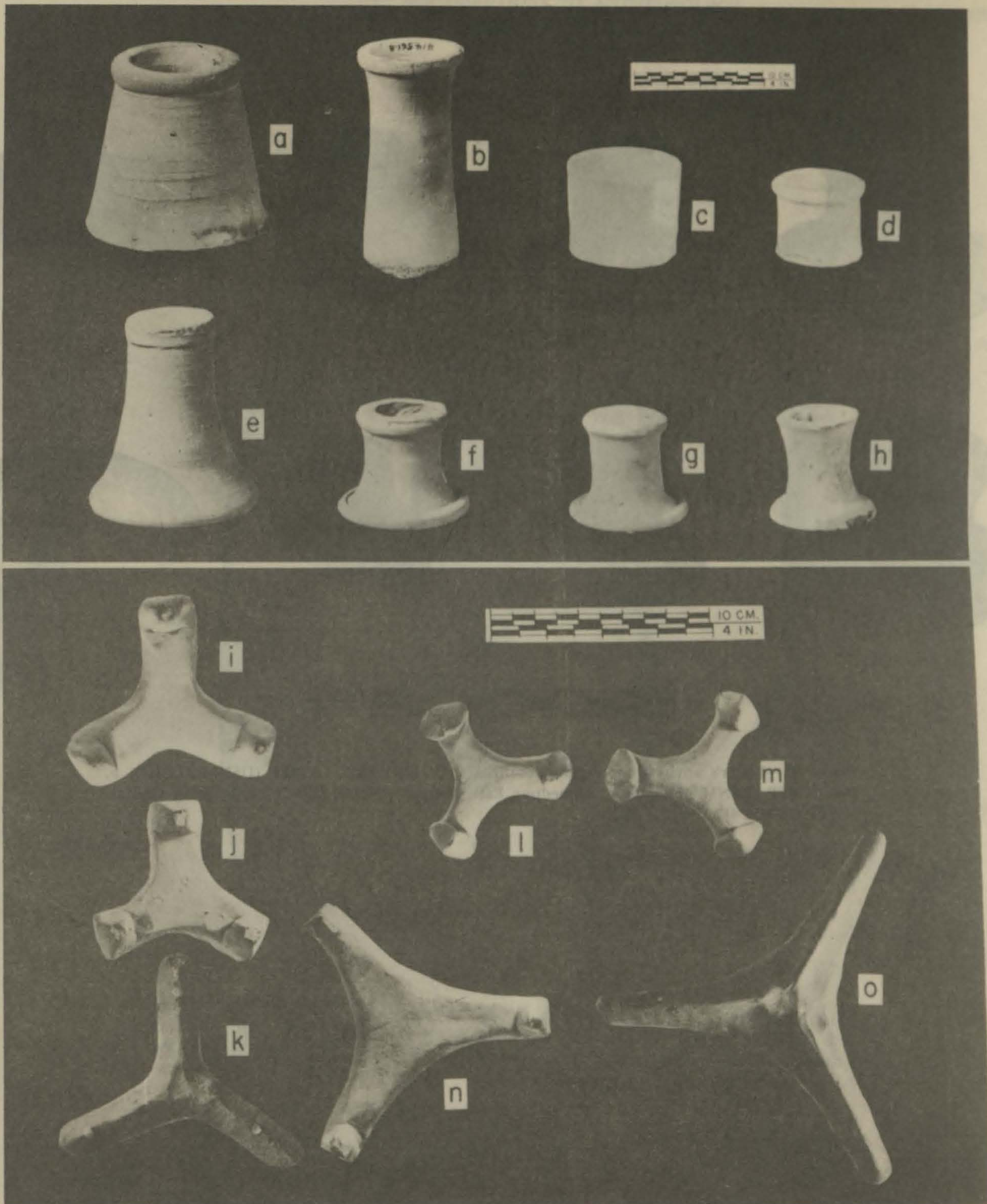


PLATE 81.—Setters for supporting glazed ware in kiln during firing: *a*, prop, Quetta (USNM 414,561-C); *b*, prop, Quetta (USNM 414,561-B); *c*, prop, Quetta (USNM 414,561-A); *d*, prop, Quetta (USNM 417,184); *e*, props, Pabbi, NWFP (USNM 417,309-D); *f*, props, Pabbi, NWFP (USNM 417,309-C); *g*, props, Pabbi, NWFP (USNM 417,309-B); *h*, props, Pabbi, NWFP (USNM 417,309-A); *i*, stilts, Quetta (USNM 414,560); *j*, stilts, Quetta (USNM 417,183-A); *k*, stilts, Quetta (USNM 417,183-B); *l*, stilts, Pabbi, NWFP (USNM 417,310-A); *m*, stilts, Pabbi, NWFP (USNM 417,310-B); *n*, stilts, Hala, Sind (USNM 417,125-B); *o*, stilts, Hala, Sind (USNM 417,125-A).



PLATE 82.—Overfired vessels: *a, kūzā* Shahbaz Ahmed Khel, NWFP (USNM 417,268), fired to olive green color (unglazed), note distortion at shoulder, cracking; *b, cilam,* Zakhel Bala, NWFP (USNM 417,313), extensive bloating and fusion on one side, neck broken off, green lead glaze changed to bright red (copper red) in the most overfired areas, indicating reduction on those areas, green color retained on other parts.

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